THE UNIVERSITY OF MICHIGAN

OCTOBER 16, 1961

OCT 18 1961
ENGINEERING LIBRARY

missiles and rockets

THE MISSILE/SPACE WEEKLY

Bell's Communications Satellite

Report from Biggest ARS Meeting . . .
NASA Considers Interim M-I-S Prograı
Air-Bearings Enhance Gyro Testing 26

AN AMERICAN AVIATION PUBLICATION

Double-Wall by Bell — symbolized

BELL COOLS THE HEAT OF HOMECOMING

Atmospheric friction which will slow tomorrow's returning space vehicles to safe landing speeds can make cinders of both space ship and occupants.

Bell Aerosystems has worked since the days of the X-1 supersonic research plane to beat this heat. We call our system Double-Wall. We've tested it — and we know it works.

Double-Wall is made up of a heat-sustaining outer wall, a sublayer of thermal insulation and a cooled inner wall. The fundamental principle behind this arrangement is the separation of the heat-sustaining and load-carrying functions of the airframe.

The outer wall is made up of small heat-resistant panels designed to withstand severe heating. It carries no structural loads, but serves as an effective heat shield by radiating most of the re-entry heat back to the atmosphere.

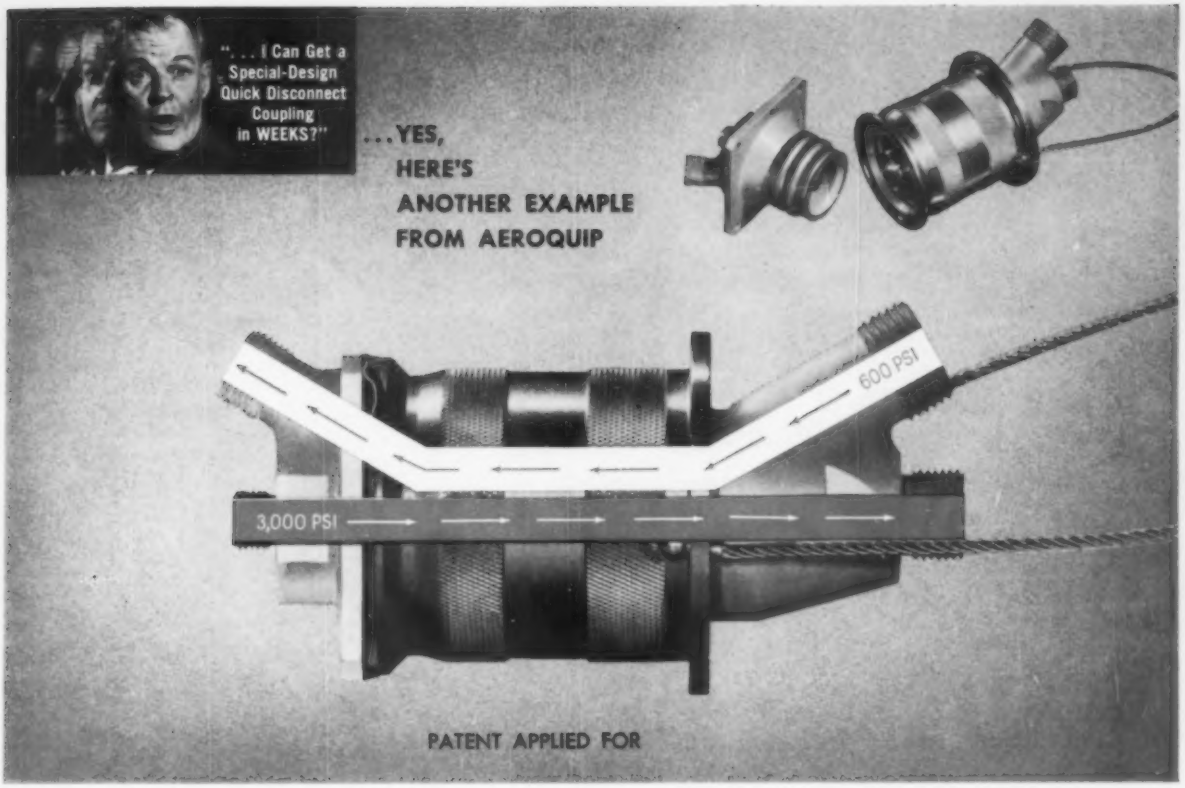
The layer of protective insulation is used beneath these panels to resist the flow of heat to the inner wall. The small amount of heat that does penetrate this insulation is absorbed and dissipated by an effective cooling system. Therefore, though outer wall temperatures may soar above 2000° F, the inner wall temperature will not rise above 200° F.

Significantly, the load-carrying structure is kept cool and strong, independent of external heating, and conventional aluminum construction can be utilized. As an added bonus, the Bell Double-Wall's unique arrangement of thermal barriers automatically provides a moderate environment for both crew and equipment.

Double-Wall is only one of the many contributions Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing our challenging and rewarding future.

BELL AEROSYSTEMS COMPANY
BUFFALO 5, N. Y.
DIVISION OF BELL AEROSPACE CORPORATION
A TEXTRON COMPANY

Circle No. 1 on Subscriber Service Card


"... I Can Get a Special-Design Quick Disconnect Coupling in WEEKS?"
...YES, HERE'S ANOTHER EXAMPLE FROM AEROQUIP
600 PSI
3,000 PSI
PATENT APPLIED FOR

New Dual Flow Quick Disconnect Allows Pressure and Return or Two Separate Fluid Systems

UNIQUE DESIGN OPTIONS PROVIDE NUMEROUS SYSTEMS POSSIBILITIES

An extraordinary quick disconnect utilizing two concentric fluid passages within a single coupling was developed by Aeroquip to help solve an umbilical connection problem on a second generation missile. This advanced design assures simultaneous connection or disconnection of both hydraulic pressure and return systems, required to protect system components on the missile.

Further research on the basic concept of concentric couplings by Aeroquip engineers led to a wide range of design possibilities now being employed on other systems. For example, two different fluids can be handled through one coupling. Or, addition of an integral by-pass valve port permits fluid circulation between passages in each coupling half upon disconnection—ideal for series circuits or for self-purging systems.

Aeroquip's superior coupling capability has been demonstrated many times by the development of special quick disconnects, such as this concentric coupling, to meet the requirements of a wide range of users. Your fluid line problems can be solved, too, by Aeroquip's unmatched engineering team. Mail the coupon below for details.

PUSH-PULL and SAF-LOC are Aeroquip Trademarks

COUPLINGS FOR THESE FLUIDS:
HYDRAULICS
PNEUMATICS
FUEL
LUBE OIL
CORROSIVE FLUIDS
GASES AND
ELECTRONIC COOLANTS

THESE COUPLING TYPES:
THREADED
PUSH-PULL
BREAKAWAY
REMOTE CONTROL
SELF-SEALING
MINIATURIZED
SAF-LOC
. . . AND MANY OTHER TYPES

Aeroquip

AEROQUIP CORPORATION • JACKSON, MICHIGAN
AIRCRAFT DIVISION
JACKSON PLANT, JACKSON, MICHIGAN • BLAKESLEE PLANT, JACKSON, MICHIGAN
DALLAS PLANT, DALLAS, TEXAS • WESTERN PLANT, BURBANK, CALIFORNIA
In Canada: Aeroquip (Canada) Ltd., Toronto 19, Ontario
In Germany: Aeroquip G.m.b.H., Baden Baden-Oos
AEROQUIP PRODUCTS ARE PROTECTED BY PATENTS IN U.S.A., CANADA AND ABROAD

Aeroquip Corporation, Jackson, Mich.
Please send me a copy of Bulletin No. 254 M & R-10

Name_____
Title_____
Company_____
Address_____
City_____ Zone_____ State_____
Would you like to talk to a sales engineer about your application? ☐ Yes

Circle No. 2 on Subscriber Service Card

ROOM TO THINK...

Working at MITRE gives you the opportunity to investigate new scientific areas, and, at the same time, to become identified with projects of the utmost national urgency. The effort involves a wide range of computer-based command and control systems. You will face important and challenging problems . . . and be free to pursue them on your own. Your colleagues will be men of considerable professional stature who work in an atmosphere of intellectual freedom. This is a job for the highly talented scientist or engineer — the man with imagination, common sense, and a feel for systems. If you qualify, and if you are prepared to accept the challenge of command and control systems, MITRE needs you now. Write, in confidence, to Vice President — Technical Operations. The MITRE Corporation. Post Office Box 208, Dept. **WE12**, Bedford, Massachusetts.

Appointments are now being made in the following areas:

- Operations Research
- System Analysis
- Communications
- Econometrics
- Economics
- Computer Technology
- Human Factors
- Advanced System Design
- Mathematics
- Radar Systems and Techniques
- Air Traffic Control System Development
- Antenna Design — Microwave Components

Formed under the sponsorship of the Massachusetts Institute of Technology and now serving as Technical Advisor to the United States Air Force Electronic Systems Division.

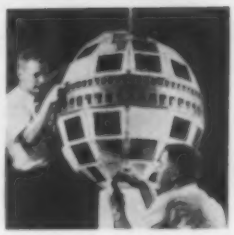
An equal opportunity employer

THE MITRE CORPORATION

THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 16 October 16, 1961



THE COVER

A popular exhibit at the ARS meeting was this full-scale model of Bell's experimental active communications satellite, due for first launch in April. See p. 48.

OCTOBER 16 HEADLINES

Technical Progress Theme of Largest ARS Meeting 14
NASA Considers New M-I-S Program to Fill Gap 17
First Saturn Launch to Be Fateful Step Forward 17
NEC Meeting Hears of Radically New 3-D Systems 49

MISSILE SYSTEMS

Sergeant Will Add to Army's Tactical Mobility 21

ELECTRONICS

Air-Bearings Point to Improved Gyro Testing 26

SPACE SYSTEMS

Ground Controls to Benefit NASA's SYNCOM 31

SUPPORT EQUIPMENT

Saturn S-IV Transportation, Handling Problems 32

DEPARTMENTS

Letters 6
The Countdown 9
The Missile/Space Week† 11
Technical Countdown 25
Industry 44
Names in the News 50
Products & Processes 52
Contracts 56
When and Where 57
Editorial 58

†U.S. Reg. Pdg.

35,702 copies this issue

President ..... Wayne W. Parrish
General Manager ..... Leonard A. Eiserer
Editorial Director ..... Fred S. Hunter

Editor
William J. Coughlin

Managing Editor
William E. Howard

Senior Editors
James Baar ..... Military Affairs
Charles D. LeFond ..... Electronics

News Editor
Reed Bundy

Associate Editors
William Beller ..... Engineering
Heather M. David ..... Space Medicine
John F. Judge ..... Advanced Materials
Frank G. McGuire ..... Propulsion
David Newman ..... Industry
Hal Taylor ..... NASA
James Trainor ..... Support Equipment
Bill Wilks ..... Business

Contributing Editors
James J. Haggerty, Dr. I. M. Levitt, Michael Lorenzo, Dr. Albert Parry, Dr. Hubertus Strughold, G. V. E. Thompson.

Floyd G. Arpan ..... Editorial Consultant
Mary B. Booth ..... Editorial Assistant
William Martin ..... Art Director
Bacil Guiley ..... Assistant Art Director

BUREAUS
LOS ANGELES ..... 8929 Wilshire Blvd., Beverly Hills
Richard van Osten ..... Bureau Chief
NEW YORK ..... 20 East 46th Street
PARIS ..... 11 Rue Condorcet
Jean-Marie Riche
GENEVA ..... 10 Rue Grenus
Anthony Vandyk

EDITORIAL ADVISORY BOARD
Dr. Peter Castruccio — Alexander Satin
Conrad H. Hoeppner — Dr. Eugen Saenger
Richard F. Gompertz — Robert P. Haviland
Vice Adm. Harry Sanders (ret.)

Edward D. Muhlfeld
Publisher

Paul B. Kinney ..... Eastern Advertising Manager
Craig L. Mason ..... Director of Research
Ron Thorstenson ..... Sales Promotion Manager
John N. Carlin ..... Director of Circulation
Eugene White ..... Circulation Manager
R. Virgil Parker ..... Production Manager
Barbara Barnett ..... Production Assistant

Published each Monday with the exception of the last Monday in December by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Cable Address: AMERAV.

Printed at Judd & Detweiler, Inc., Washington, D.C. Second class postage paid at Washington, D.C. Copyright 1961, American Aviation Publications, Inc.

Subscription rate: U.S. and Possessions, Canada, and Pan American Postal Union Nations: 1 year $5.00, 2 years $8.00, 3 years $10.00. All other foreign: 1 year $15.00, 2 years $25.00, 3 years $35.00. Single copy prices: regular issues 50 cents each; special issues $1.00 each. Subscriptions are solicited only from persons with identifiable commercial or professional interests in the missile/space industry. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr. Missiles and Rockets, 1001 Vermont Ave., N.W., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.

Senior level
DYNA-SOAR SPACE GLIDER
structural design openings

One of the most advanced programs in the country, the Dyna-Soar manned space glider, offers structural design engineers immediate openings of significant scope and challenge. Positions are with the Aero-Space Division of The Boeing Company, system contractor for Dyna-Soar.

The Dyna-Soar glider, in returning to earth from space, experiences a flight regime ranging from orbital to normal landing speeds, and is subjected to extreme air loads and temperatures with attendant high heating rates, high differential temperatures, oxidation of materials, material creep and elongation. These conditions, requiring innovations in structural concepts and testing techniques, offer assignments in such advanced design areas as wing leading edges and surfaces, fuselage and wing primary structure, windows and window mounts, and nose cap.

Minimum requirements are a B.S. in Aeronautical or Mechanical Engineering with four years of applicable experience. Salaries are commensurate with your educational and experience background. Assignments are in Seattle, in the uncongested Pacific Northwest, famous for mild year-round climate, excellent schools and housing, and healthful outdoor living for the whole family.

Send your resume today, to Mr. W. B. Evans, The Boeing Company, P. O. Box 3707 - MRI, Seattle 24, Washington. An equal opportunity employer.

BOEING

letters

Too Much Organization

To the Editor:

Upon my return from a trip to Europe last week I found your editorial ("Apollo Beset by Avarice") in the Aug. 28 M/R.

You have a good point and I too am very much concerned that we may end up second best in both aircraft and space. The reason for all this I am sure is our present over-organization. While large projects admittedly require large organizations, we seem to have gone too far and are, I am afraid, losing our capability to produce economically and quickly.

Keep up the good work. Perhaps if we all keep at it we may be able to influence the situation favorably.

E. H. Heinemann
Executive Vice President
Guidance Technology, Inc.
Santa Monica, Calif.

Early Flare Warning

To the Editor:

In M/R, Aug. 7, p 30, Mr. William Beller writes in his article: "Solar Ray Storm Prediction Improved": "The danger of solar streams to astronauts was first recognized when a flare on May 12, 1959, sent protons of extremely high energies throughout the solar system."

May I point out that this danger was predicted in a paper to the 6th Astronautical Congress held in Copenhagen, 1955. Parts of it were repeated in a lecture to the 10th Astronautical Congress held in London in 1959. The title of the original paper was "The Great Danger: The Corpuscular Rays From the Sun."

For various reasons, it was concluded that the sun sometimes ejects plasma at speeds exceeding the gravity escape speed. There are different forms of ejection. The very interesting, but infrequent, surge eruptions go perpendicularly away. The luminous clouds are sometimes quite separated from the ejection point and may proceed as "shots," as directly observed.

Such clouds of charged particles will, under certain conditions, proceed collected instead of spreading (W. H. Bennett, Phys. Rev. 1955, v.98, p. 1584-1593).

On the other hand, it may presumably stretch out.

If the acceleration process in the sun is of electromagnetic nature, the electrons should presumably have energies of the same order as the protons, though they should not have greater stream speeds.

When a particle stream hits the earth's atmosphere, the nuclei will have definite path lengths and penetration depths. From the observed data, the energies were calculated to be often about 10^5 electronvolts. But, as the particles are spiralling, their real path lengths and energies must be much greater.

From the intensity of the aurora light when brightest, the energies were calculated to be 3×10^{-3} cal.cm^{-2} sec^{-1} in extreme cases; i.e., 10^5 erg or 10^{17} ev. With a factor of 10^2 for the whole spectrum, the result would be about 10^{19} ev.

When this amount was compared with the energy per particle, the particle flux turned out to be about 10^{12} cm^{-2} sec^{-1}, if the energy per particle was 10^6 ev. That was almost as much as the flux of a beam from a small cyclotron. But the solar streams would be much more dangerous because of the presence of electrons, giving rise to X-rays.

I mentioned that if only 1^{-4} of the energy coming in per cm^2 was transformed into X-rays being absorbed in 1 cm^3 of flesh, the average dose would be about 10 roentgen per sec.—than the lethal dose.

The Copenhagen paper also dealt with another form of particle emission from the sun—observed only at high geomagnetic latitudes, coming in outspread form and only during the half of the sun revolution period, not associated with sun spots.

Dr. Johannes Olsen studied these phenomenon in Northern Greenland by geomagnetic methods and traced them continuously from 1926 to '41—that is, through about 200 sun-revolution periods (Geomagnetism and Atmospheric Electricity, 1948, p. 123-34).

It seemed evident that the sun has an unfriendly and a friendly side when seen apart from the sun-spot areas (potential flare areas). Hence I suggested that any human space flights should be undertaken only when no sun spots are facing the earth and only when the sun turns its friendly face towards us.

Now, one would also claim other conditions. But this suggestion was made long before the recent discoveries.

In London, I also called attention to this problem: If any radiation may be measured to show the periodicity of the 26.83 days calculated by Dr. Olsen, the conclusion is that its origin is in the sun.

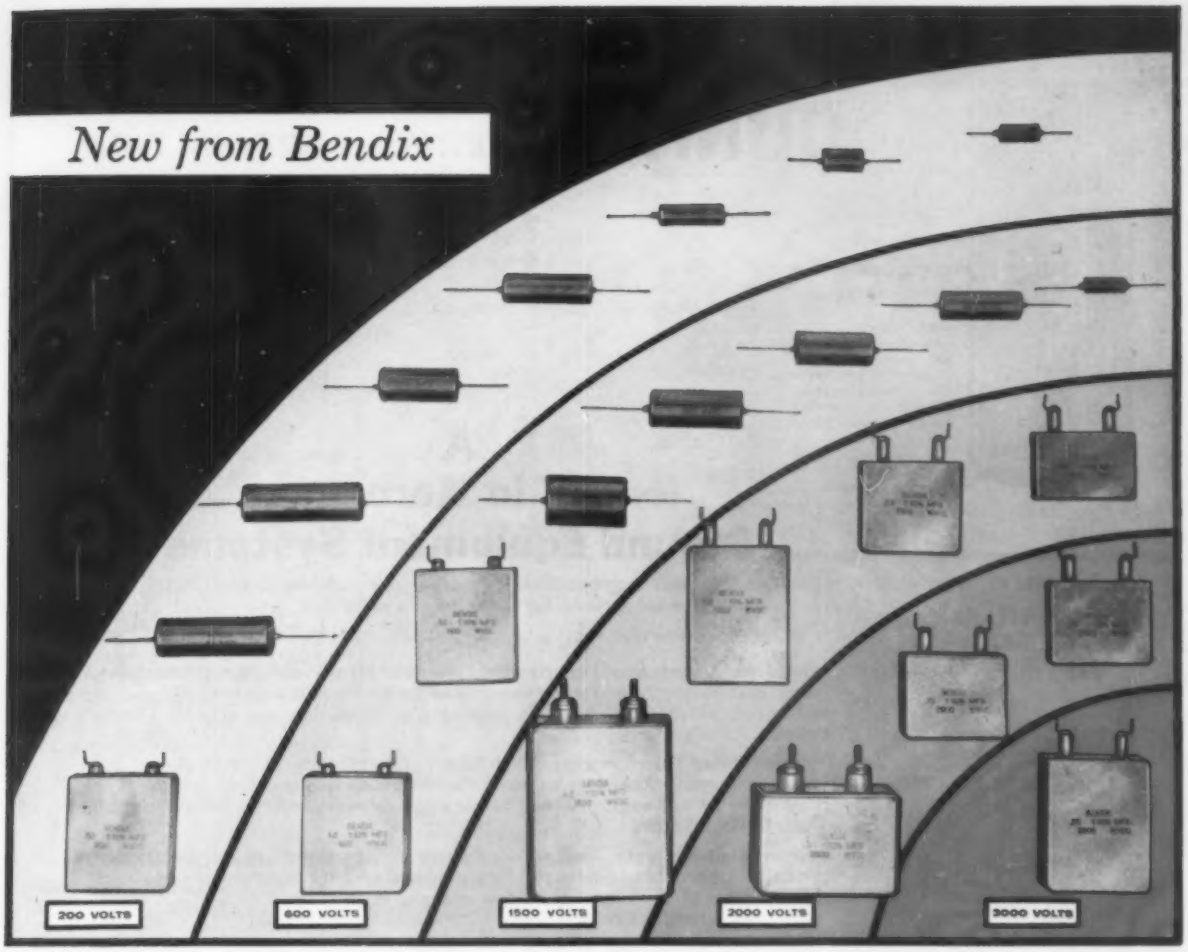
Dr. Olsen has, from the remarkable constancy of the periodicity and its long durability compared to the different revolution times and the short lives of the sun spots, suggested that radiation in question originates deep in the sun.

Hence, one must assume that the particles were neutrons when ejected from the sun, and later disintegrated into protons (representing another danger).

From this it follows that any confirmation of a 26.83-day period will be proof of a phenomenon developing from the plasma material deep under the glowing surface of the sun. . . .

Carl E. Andersen
Technical University of Copenhagen
Denmark

Satellite and rocket measurements of the lethality of solar radiation bear out Dr. Andersen's contentions, reached by theoretical means years earlier. Cf. paper by Russian scientist V. I. Krassovsky, "On the Hardest Solar Corpuscles," presented at XII International Astronautical Congress, 1961, Wash., D.C.—Ed.



E-200 HIGH TEMPERATURE CAPACITORS

Operable to +200°C.

The Bendix® E-200 series of lightweight, small size capacitors is designed for installations requiring a high degree of component reliability at operating temperatures as high as 200°C.

High temperature capability and mica-like electrical characteristics enable the E-200 series to withstand extremely high orders of AC in small envelope size at all ambients under 200°C.

The new series is designed and manufactured to a Bendix specification which is patterned after the high reliability specification MIL-C-14157B, proposed.

Hermetically sealed in tubular or rectangular housings, these capacitors offer superior resistance to mechanical and climatic environments.

E-200 CHARACTERISTICS: • Wound mica papers • Solid impregnants • Exceptional stability • High insulation resistance • Radiation resistance • Outstanding dependability

For full details, write

Scintilla Division
SIDNEY, NEW YORK

THE Bendix CORPORATION

Canadian Affiliate: Aviation Electric, Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

Circle No. 3 on Subscriber Service Card

DUNN *ENGINEERING CORPORATION*

A leader in Aerospace Ground Equipment Systems

Dunn Engineering specializes in the design, development, and fabrication of electronic systems for the aerospace industry.

Dunn experience includes:

Radome & Antenna Test Systems...Semi-automatic and manual test systems custom engineered to measure and verify various parameters — cross talk error, attenuation and gain values, dish ellipticity, and others. (Dunn Bulletin R1000)

Dynamometer Test Systems...Evaluation of dynamic characteristics of gyro spin motors; microsyn transducers as used in a closed-loop torque-nulling system. Typical systems include excitation and power supplies, servo/electronics and controls. (Dunn Bulletin T1150)

Inertial Test Systems...Test and evaluation of dynamic and static performance of complete inertial and gimbal platform guidance systems; substantial experience and background in inertial packages utilizing HIG gyros, PIG & PIGA units, stable platforms, and related items. (Dunn Bulletin T818/T918)

Dunn Engineering participation in Defense Department programs includes Talos, Polaris, Sparrow, Hawk, Discoverer, Midas, Atlas and Saturn. Close customer liaison, both in proprietary products and custom-specification-designed equipment, is a basic tenet of Dunn and results in lower costs and faster delivery for Dunn customers.

Dunn engineers are specialists in microwave testing, r. f. systems, digital systems and techniques, and inertial systems. A Dunn specialist is as close to you as your telephone. UNiversity 4-6700.

Comprehensive literature will be forwarded upon request.

The new Dunn facility at 38 Henry Street, Cambridge, (more than tripling present floor area) will be ready for occupancy in October.

DUNN ENGINEERING
CORPORATION
225 O'BRIEN HIGHWAY
CAMBRIDGE,
MASS.

Circle No. 4 on Subscriber Service Card

The Countdown

WASHINGTON

Zeus: The Question Remains

Despite reports to the contrary, neither the White House nor Defense Secretary McNamara has decided to push for *Nike-Zeus* production in FY '63. To date, DOD guidelines are reported to call only for continued R&D; deployment plans remain on the shelf.

New Polaris Subs: How Many?

Defense Department is still juggling various number combinations in connection with authorizing more *Polaris* submarines in FY '63. The hardest figure to date is six and six: a package authorizing six additional ships and long-lead-time items for six more. That would bring the total number authorized in FY '63 to 35 and presumably 41 in FY '64.

Pentagon Again Looks at the MRBM

Defense Department interest in developmen. new MRBM with a range of about 1000 miles is once more on the rise. This is favored over use of an upgraded *Pershing* or a modified *Polaris*.

NASA vs. the Military

A controversial report calling for general supervision by NASA of all Defense Dept. R&D for military space communications has been issued by the House Space Committee. This could result in a lively battle. The committee says NASA should supervise the work since its statutory authority directs the agency to "plan, direct and conduct, aeronautical space activities."

Cost of Mobile vs. Fixed

Air Force estimates on the cost of mobile *Minuteman* show that the system is expected to cost about 2.5 times as much per missile as the fixed-base model. The Defense Department is proposing a resumption of new funding for the mobile R&D program under the present guidelines for the FY '63 budget.

Ambitious NASA Space Planning

NASA's advanced space planners believe large manned space stations in a 300-mi. earth orbit will be feasible in 1968-69; a permanent manned moon station will exist in 1970 and can be expanded into a lunar colony by 1975; manned planetary expeditions can start in 1972-74 with a view to the arrival of a 100-man expedition on Mars in 1980; the U.S. will be able to support 500 roundtrips to the moon in 1975 without undue strain on the national budget; commercial passenger and cargo space flights will be economically feasible in 1975-80.

Senate Booster Hearings Rescheduled

The Senate Space Committee has tentatively rescheduled its public hearings on the *Centaur* and *Saturn* launch vehicle programs for sometime in November. No final date will be set until committee chairman Sen. Robert Kerr (D-Okla.) returns from a fact-finding trip to NASA and industry West Coast locations. Hearings also will consider other aspects of the U.S. space program.

INDUSTRY

Booster Proposed for X-15

NASA is not enthusiastic over a proposal that a two-stage *Blue Scout* rocket be used as a recoverable booster for a surface launch of the *X-15*. Proposal is being pushed by Aeronutronic and North American Aviation.

Exit Discoverer, Enter Ranger

Discoverer XXXIV, last of the successful Lockheed series, now is being readied on the launch pad at Vandenberg AFB. The *Thor* pad will be modified at a cost of $500,000 for future NASA use. . . . Also ready to go is *Ranger II*, scheduled for launch this week from Cape Canaveral. It will carry the same equipment as the ill-fated *Ranger I* which burned up in the earth's atmosphere in late August after failing to achieve its highly elliptical orbit.

Saturn Bids Due

Only 10 of the 37 firms invited to bid on the *Saturn C-1* contract are expected to submit bids by the Oct. 16 deadline. They will include Aeronutronic, Boeing, General Dynamics/Astronautics and Chrysler.

INTERNATIONAL

Germans Count Russian Missiles

Bundeswehr, official publication of West Germany's armed forces, says the Soviet Union will have 200 intercontinental missiles available this winter. The magazine says the Soviets have 35 to 50 *T-3* missiles now operational, with a rapid production buildup to make 150 more available in the winter of 1961/62. It reports that ten launching bases are operational and sites for an additional 27 bases are known.

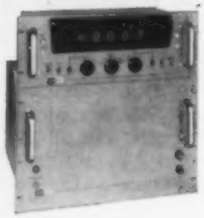
French Space Budget Disclosed

The new French budget earmarks the equivalent of some $18 million for missile/space research. A little more than half of this will be used to finance domestic projects, including work on a ballistic missile whose engine could be used to boost a 100-lb. satellite into orbit in 1964-65. The remainder of the funds will be spent on European cooperative programs.

Getting Ready for Vostok III?

Russia's space tracking ships were last reported to be taking on supplies at a North African port—possibly in preparation for the launching of *Vostok III*. There has been speculation in western capitals for weeks that the Soviets will time *Vostok III* for the party congress in Moscow later this month—or for the anniversary of the revolution in early November.

NOW! standards lab precision... with military reliability!



Rugged new KIN TEL programmable Digital Voltmeter designed to MIL-E-4158A ...measures AC and DC from 0.001 to 999.9 volts with an accuracy of 0.01% ±1 digit DC, 0.1% AC

USED IN MAJOR MISSILE PROGRAMS. Extensively tested and proved in the field in missile checkout systems, the Model 412 Digital Voltmeter is designed to meet the stringent environmental requirements of MIL-E-4158A for operational ground support equipment. These units have established an unprecedented record of reliability and accuracy in daily service for ICBM testing.

DESIGNED FOR AUTOMATIC SYSTEMS. All major control functions can be remotely programmed... the readout unit remotely mounted in as little as 3½" of rack space. Two isolated input channels are provided, with AC and DC measurement mode and automatic or manual ranging independent for each channel. Digital recorder drive capability is built in.

THE ONLY DIFFERENTIAL DIGITAL VOLTMETER. Completely isolated, guarded inputs eliminate ground loop problems, reject common-mode hum and noise, allow stable, accurate AC or DC measurement at differing ground potentials — regardless of whether printer or other output equipment is grounded or floating.

TEST MISSILES OR TRANSISTORS. If you can't afford down time at the wrong time, if you must have continuous, reliable operation even under adverse environmental conditions, if you need automatic system capability, high accuracy, versatility, then this new KIN TEL Digital Voltmeter meets *your* requirements. Write for technical literature or demonstration. Representatives in all major cities.

BRIEF TECHNICAL SPECIFICATIONS

DC RANGE:
±0.001 to ±999.9 volts in 3 automatic or manual ranges, automatic polarity.

AC RANGE:
0.001 to 999.9 volts, in 3 automatic or manual ranges, 60 to 1000 cps.

ACCURACY:
0.1% of FS for AC, 0.01% ±1 digit of reading for DC.

INPUT IMPEDANCE:
10 megohms for DC, 1 megohm and 200 μμf for AC.

COMMON MODE REJECTION:
86 db minimum for 60 cps common-mode signals.

OPERATIONAL FEATURES:
All controls remotely programmable, built-in digital recorder drive, two isolated input channels with range control and AC or DC mode independent for each channel.

5725 Kearny Villa Road,
San Diego 11, California
Phone: BRowning 7-6700

COHU
ELECTRONICS, INC
KIN TEL DIVISION

Circle No. 5 on Subscriber Service Card

The Missile/Space Week

Non-Profit ComSat Plan

A special industry committee was ready last week to recommend that a non-profit corporation be set up to own and operate a commercial communications satellite system (M/R, July 31, p. 17).

The report by a 10-member group of international communications carriers was due at the Federal Communications Commission on Oct. 13.

The non-profit corporation's board of directors would have equal representation by all carriers using the system, plus public members appointed by the President.

The contributions of each of the carriers to the capital of the corporation would be equal to their use of the system.

Ground stations would be owned by the carriers using them. Two members of the committee, RCA and Western Union, were expected to file a dissenting report which calls for the corporation to own the ground stations to insure that all carriers will be able to use them.

Another provision of the ownership plan is compulsory competitive bidding on all purchases of supplies and equipment.

Submission of the report will kick off further controversy and discussion with Congress and the Kennedy Administration over who should control and reap the benefits of the first commercial outgrowth of space technology.

The Senate Monopoly Subcommittee has already scheduled hearings Nov. 8 and 9 on the industry's ownership plan.

Discussions also have been held within the Kennedy Administration on possible alternative ownership plans in the event that the industry's plan is declared inadequate.

Among those considered was an interim government ownership setup.

Administration officials want to insure that private ownership of the system does not result in one or more large carriers controlling the system. They also want to insure that the system is open to all foreign countries which want to use it.

Although the FCC regulates communication carriers, a final decision on ownership will probably be made within the Administration, with the National Space Council, NASA and the Justice Department playing major roles. NASA will also be given the role of setting the equipment requirements for the system, plus the launching of all satellites.

Bullpup B Getting to Know Skyhawk

A COMPATIBILITY PROGRAM mating the Navy's Bullpup B missile with the Douglas A4D now is well advanced. Three of the Bullpups are shown here under the wing of the Skyhawk. Grumman's A2F-1 is being flight-tested carrying a load of five Bullpup B's.

Shots of the Week

• A *Nike-Zeus* destroyed itself several seconds after launch Oct. 7 in the AICBM's second failure within a month. Army officials said the first stage operated successfully and dropped away as planned. The second stage exploded. Apparent cause of failure—break in signals from the guidance radar.

• An *Atlas* landed in the Indian Ocean, Oct. 5, 9000 miles from its Canaveral launch site, in a nose cone re-entry test. The missile, fired on a shallower than normal trajectory, was subjected to severe re-entry stresses and heating. Its data capsule was recovered in the first retrieval from a shot of this length.

• The Soviet Union fired another of its new type rockets into the Central Pacific Oct. 7. The Soviet news agency Tass said it carried a new guidance system and travelled more than 7500 miles, impacting in the target area.

• A *Titan I* with a guidance system scheduled for use on *Titan II* flew 5000 miles down the Atlantic Missile Range Oct. 6. *Titan* box score: out of 41 shots, only 10 failures.

• NASA fired an *Argo D-4* from Wallops Island Oct. 10. The solid-fueled, four-stage rocket traveled 817 miles out over the Atlantic and reached an altitude of 585 miles. The mission was to determine density of electrically-charged helium atoms in the upper atmosphere.

• A *Pershing*, preset to perform a series of erratic in-flight maneuvers, struck "on-target" after a 150-mile flight down AMR Oct. 10. Preliminary data indicated all test objectives were met.

• Air Force Maj. Robert White piloted the *X-15* to a record 215,000 ft. on Oct. 10. This bettered its previous altitude record by almost seven miles.

Apollo Bid Teams Announced

NASA has confirmed that five firms—GE, Martin, McDonnell, General Dynamics/Astronautics, and North American Aviation—have submitted bids for the prime contract on the *Apollo* spacecraft (M/R, Oct. 9, p. 10).

The GE bidding team consists of Douglas, Grumman and Space Technology Laboratories. The McDonnell team includes Hughes, Lockheed, and Chance Vought. The other three firms

bid alone. Hour-long presentations were made on each of the bids to members of NASA's Space Task Group. An evaluation panel has been set up to make a recommendation on the bids to NASA headquarters.

Space Flight Meeting

NASA Administrator James E. Webb told the ARS meeting in New York last week that the space agency's facilities and programs will have the flexibility to take advantage of either rendezvous or direct flights to the moon.

He said that as far as rendezvous is concerned, "NASA is proceeding with the necessary fact-finding."

Sen. Warren G. Magnuson (D-Wash.) told the meeting that immediate government planning of radio frequency allocations for satellite communications is a necessity.

These, the Senator said, should be ready in time for the 1963 International Telecommunication Union's conference at which 108 member nations will determine frequency or bandwidth allocations for the system.

Dr. James A. Van Allen, discoverer of the Van Allen radiation belts, told a luncheon session that the nation's ambitions in space exploration have greatly outrun its basic scientific competence in space science.

He suggested financial aid to universities for studies in such fundamental fields as physics, chemistry, celestial mechanics and atmospheric research. The Iowa scientist said the initiative for the funding should come through NASA and the National Science Foundation. Dr. Van Allen, who was given the first ARS research award for his contribution to scientific research suggested that federal support of $100 million a year for the next few years would be a "generous" beginning effort.

The ARS award was presented by Donald Douglas Jr., president of Douglas Aircraft, sponsor of the award.

(See p. 14 for a full report on the New York meeting.)

NASA Salary Troubles

The Administration soon will order a study of actions needed to prevent the loss to industry of skilled government scientists.

The study is a result of Vice President Lyndon Johnson's recent trip to West Coast space facilities.

The study will be made by the National Space Council, a special panel, or the Civil Service Commission.

One top White House space advisor favors setting up a non-profit corporation which would hire top scientists for employment on NASA projects. The corporation would not be restricted by government pay scales.

NASA officials report, however, that they have no plans to set up such a corporation.

The corporation would require congressional approval.

(See editorial, p. 58)

Military Procurement Changes

Substantial changes in military procurement are on the way. There will be an increase in the level of fees to be permitted on incentive-type contracts and an attractive improvement in selection of contract types.

Pentagon officials still are working out the details. But one anticipated change calls for elimination of the present Armed Services Procurement Regulation (ASPR) limit on fees in incentive contracts. Contracting officers also are to be encouraged to use more incentive and fewer cost-plus-fixed-fee (CPFF) contracts.

Also expected is a new restriction on the authority of military contracting officers to award negotiated contracts on a non-competitive basis. At present, ASPR's provide that lack of adequate specifications can be considered a reason for using negotiation instead of advertised procurement. These situations usually result in sole-source buys. But application of the exception is limited to procurement of $50,000 unless approved by higher officials.

An upcoming revision is expected to lower this ceiling to $10,000. There probably will be exceptions to cover components vital to the functioning of an end item that ordinarily would be purchased from a sole-source contractor.

IMMEDIATE DELIVERY
OFF-THE-SHELF!

ALL 28 CONTAINER SIZES PER BUWEPS DWG. LIST 2210448

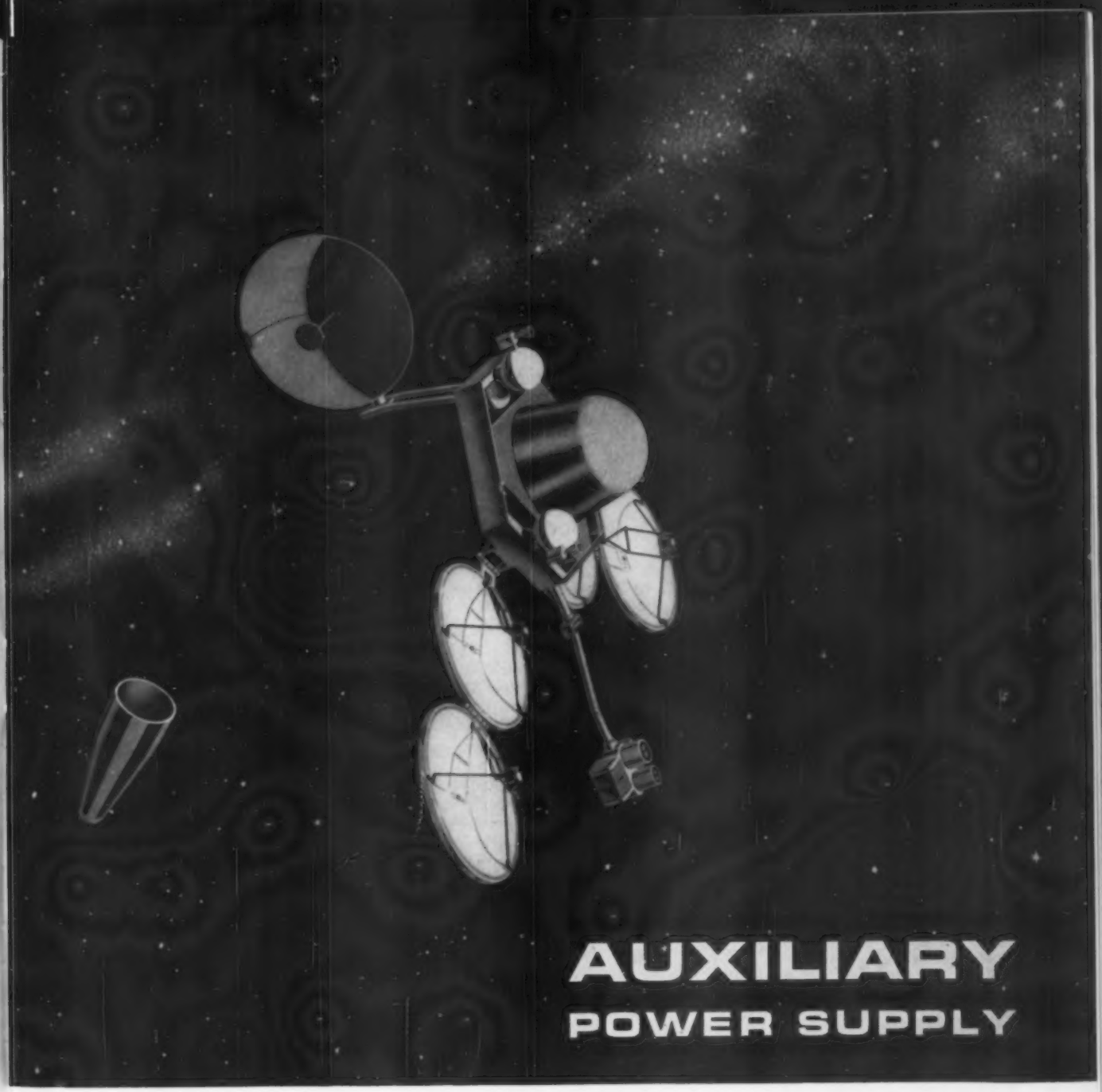
POLARIS PROGRAM

All 28 sizes of standardized containers per Navy BUWEPS Drawing List 2210448 as required for Polaris sub-system and other programs are now available for off-the-shelf delivery from both Zero facilities. These rugged, lightweight containers are equipped with latches, pressure equalizers and humidity indicators . . . meet requirements of MIL-T-945A and MIL-21200. Sizes range from 5¼" x 6⅜" to 19" x 22". Easy to accessorize, they are readily adaptable for use as portable instrument cases, transit cases, etc.

ZERO MANUFACTURING CO.
1121 Chestnut Street, Burbank, California
Telephone VIctoria 9-5521 • TWX BRB-9862
Factories in Burbank, California and Palmer, Mass.

Zero representatives in key cities nationwide

JUST OFF THE PRESS!
Write for catalog with complete specifications and details on these new cases.



AUXILIARY POWER SUPPLY

Direct conversion of heat to electricity offers the solution to the problems of auxiliary power in space.

New techniques of space charge neutralization are being developed at Ford Instrument Company under U.S. Air Force, U.S. Navy and company sponsored studies. This work offers the opportunity to obtain significant power densities with wide spaced plasma power diodes at cathode temperatures around 1200°C. Application studies currently being undertaken involve chemical, solar and nuclear heat sources.1.6

FORD INSTRUMENT CO.
DIVISION OF SPERRY RAND CORPORATION
31-10 Thomson Avenue, Long Island City 1, New York

Ford Instrument guidance and control components participated in these missile and space "firsts": First Free-World man-into-space vehicle (MERCURY-REDSTONE) • First operational ballistic missile (REDSTONE) • First successful launching of a Free-World satellite • First successfully recovered nose cone • First successful Free-World space probe.

A CREATIVE TEAM OF SCIENTIFIC, ENGINEERING AND PRODUCTION TALENT

Circle No. 6 on Subscriber Service Card

Largest Industry Exhibit—

Space Flight Report to Nation

Highlights are reported advances in propulsion, materials, nucleonics, transportation and vehicle designing

NEW YORK—Down-to-earth technical advances in propulsion and materials took the spotlight away from more exotic space projects at last week's huge American Rocket Society meeting here.

With more than 15,000 scientists and engineers attending the sessions which concluded at New York City's Coliseum yesterday, the "Space Flight Report to the Nation" was the largest aerospace meeting ever held.

Fifty-three technical sessions ranged across the entire spectrum of aerospace activities. In addition, nearly 200 exciting industrial exhibits were housed in three floors of the Coliseum to show in the reality of hardware some of the concepts discussed by the speakers.

It was, without question, one of the most fantastic displays ever seen.

While moon-crawlers and space-suits caught the attention of the general press and the fancy of the public, it was in more mundane fields of technology that real advances were disclosed.

• **Concrete progress**—These were some of the technical highlights:

—Thiokol Chemical Corp. in a sharp departure from earlier philosophy, disclosed it is investigating a segmented approach to 160-in. solid boosters as part of the feasibility program.

—Hercules Powder unveiled an on-site filament-winding concept with unlimited size capacity, based on current state-of-the-art in solid propellants and glass fabrication.

—New beryllium structures—such as foam-filled panels and strong, lightweight structural shapes for space work—were revealed for the first time.

—Boron filaments for winding motor cases and for other high-stress work were described as competitive with fiberglass.

—Nuclear power supplies with one-fourth the specific weight of high-power SNAP units were predicted for 1967.

—Potential capabilities of the Air Force *Titan II* ICBM as a booster in U.S. space missions were revealed when Aerojet-General Corp. spelled out its third-stage design.

—A vapor-cooled insulation system for a hypersonic glide vehicle was said to provide better thermal protection and significant savings in weight.

—A booster recovery program using parachutes and LSD's was strongly endorsed as a result of salt-water immersion tests conducted by NASA's Marshall Center.

—After analysis of all modes of booster transport, The Martin Co. reported that the optimum system would be movement of the very large vehicles by air.

• **Segmented rockets at Thiokol**—Segmented 160-in.-diameter solid boosters are under investigation as part of a three-pronged effort at Thiokol Chemical Corp.

A company spokesman says an integral part of the program involves adapting "existing production techniques to transportation and handling equipment for in-plant processing and shipping complete units to launching sites."

The other two areas are intended to develop a cluster of four one-piece engines, each about 240-in. in diameter and producing a thrust of five-million pounds, and to check out design of a 28-ft.-diameter engine capable of some 20 million lbs. of thrust.

Either segmented or monolithic engines of the required size and thrust for lunar missions can be available for testing within 14 to 24 months.

Thiokol experts say the degree of scale-up represented by the three preliminary designs does not present as great a technological challenge as the jump from the *Falcon* to first-stage *Minuteman*.

Transportation studies involving engine segments were made with a dimensional model at the company's Wasatch Division. Necessary shipping routes and methods for the larger engines were also conducted.

• **Ad Astra Per**—Hercules Powder unveiled a solid booster concept consisting of stacked pie-shaped segments, filament-wound on-site and reaching any desired height. One typical vehicle would use 10 million lbs. of propellant in 108 pieces.

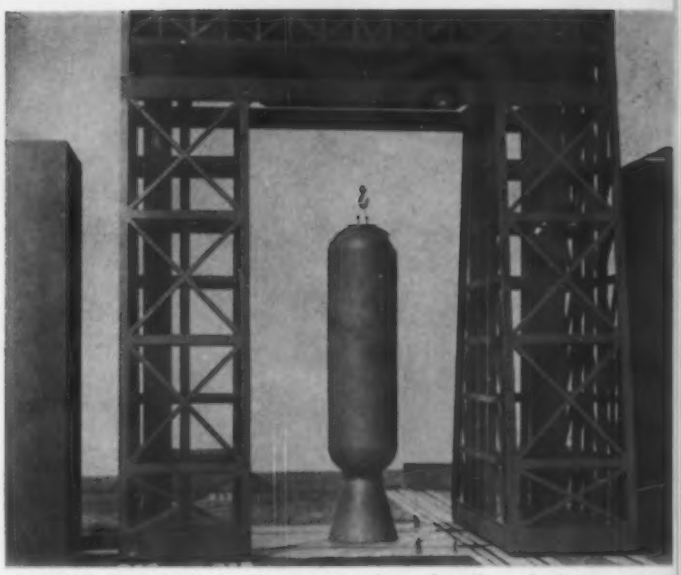
The booster would be 150 ft. high and 38 ft. wide, with a thrust of 20 million lbs. for two minutes. Another typical rocket 30 ft. across and 130 ft. high, with 13 million lbs. of thrust, would have a mass fraction of 0.9.

Its sectors are side-inhibited, and a

ARS Coverage

THIS REPORT on technical developments at the American Rocket Society meeting in New York was compiled by a MISSILES AND ROCKETS editorial team under the direction of Engineering Editor William Beller. The team included associate editors Frank McGuire, John Judge and James Trainor. Coverage of electronic and space medicine activities at the ARS show will appear in next week's issue.

PROPELLANT SEGMENTS of huge Hercules booster are positioned within an adapter band on nozzle before wrapping.



MASSIVE BOOSTER is filament-wound on launch pads in Hercules concept. Assembly building separates and moves away.

complete section burns radially. Additional segments add surface but do not alter the shape of the ballistic trace.

In a 72-sector rocket, a crack running the full distance from star point to case, with both sides exposed and burning, would add less than 1.5% to the pressure level.

In the vertical assembly, a center support structure is used for locating and indexing propellant sections. The nozzle can be fabricated in two ways, by filament winding or by integral molding with asbestos/phenolic panels. The unit must be able to support the weight of the finished rocket.

One major consideration, says Hercules experts, is the behavior of the propellant sections. Analysis shows that the most severe consequences are shear deflection and radial growth of the lower segments. Shear deflection is dependent on propellant overhang. If the only unsupported part is 3 ft. of the star point, deflection amounts to about 2 in. But if 6 ft. overhang with no taper, the deflection is 10 in. Compressive loading is prevented by inhibitors and the original circumferential windings. The propellant is essentially contained before the load is applied.

Ignition is best accomplished with a small rocket in the forward head. A multinozzle design is best—one from which gas is ejected in many directions. Calculations have shown that a 5-million-lb. rocket can be ignited with 2500 lbs. of propellant.

Size is completely arbitrary, says Hercules, and the entire concept is based on current state of the art. The firm exhibited a working model of the filament winding machine.

• **Liquid spurt**—A third-stage propulsion system for use with *Titan II*, when that ICBM is openly tagged for a space-booster role, was revealed by Aerojet-General Corp.

The company said the vehicle, designated *Hylas-Star*, could boost over 12,000 lbs. to escape velocity. The pressure-fed engine, using liquid hydrogen and oxygen to develop 20,000 lbs. thrust, would operate at low chamber pressures on the order of 100-200 psi.

Burning time would be dependent on tankage design, but estimates place this between 200 and 300 seconds, with a possible requirement for 500 seconds.

Thus far, the *Hylas-Star* is an Aerojet-funded project, and no significant amount of hardware fabrication has been carried out. It is planned as a simple, low-cost unit designed specifically for *Titan II*, but Air Force officials have stated that the big ICBM will be used for space missions with or without a third stage.

With a powerful third stage on it, however, *Titan II* could duplicate the Soviet Union's Venus probe, which sent about 14,000 lbs. toward that planet. Aerojet officials feel that the Soviet shot had less sophistication than *Titan II* incorporates, and the U.S. missile thus could make a Venus trajectory with lesser thrust.

Agena-B could reportedly put 8000 lbs. in an escape trajectory, and the proposed *Draco* stage of STL/Bell (M/R, Oct. 2, p. 24) could place 3000 lbs. in a 24-hour orbit—the *Advent* communications satellite mission. In addition, *Centaur* and *Able-Star* have been considered as third stages.

Both Aerojet and The Martin Company, prime contractors on *Titan II*, feel the missile will far exceed the success record of its predecessor when flight-testing begins later this year or early next year.

• **Nova nuggets**—In addition to unveiling its *Hylas-Star* stage for *Titan II*, Aerojet described its candidate for upper-stage use on *Nova*.

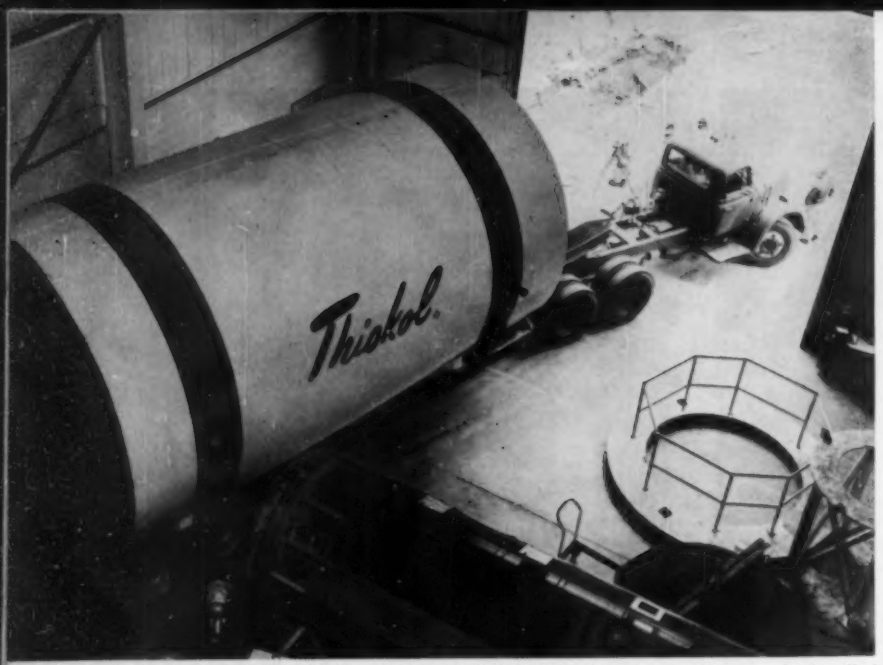
This LOX/hydrogen system would be single-barreled in its basic configuration, and develop 1-1.5-million-lbs. thrust. Its pump-fed nature is conventional, and Aerojet sees no ignition problems with the propellant mixture, even when a double or multiple-barreled stage is designed. NASA is believed to be interested in the vehicle, which would probably have a nuclear final stage.

In the first-stage field, Aerojet indicated considerable interest in a single-barreled, 6-10-million-lbs.-thrust liquid rocket engine using either storable fuels or hydrogen/oxygen. This engine, the next step beyond the Rocketdyne F-1, is now under study at Aerojet's Sacramento plant.

• **New beryllium structures**—Beryllium, the metal with the highest strength-weight ratio, showed up in new forms when The Beryllium Corp. displayed foam-filled panels made of the metal.

These panels comprise two beryllium sheets sandwiching a beryllium-oxide foam center. The assembly forms a lightweight design with good heat-resistant properties.

The company told M/R that production has advanced to the point that some standard-size panels are available off-the-shelf. They have a melting point over 3400°F, weight of 28 lb./cu. in.,



FULL-SCALE MOCKUP shows how Thiokol's 160-in. booster segments can be handled by currently available road equipment—both in-plant and cross-country.

and compressive strength of over 800 psi.

The company also staged what is perhaps the first public display of beryllium in standard structural shapes such as angles and channels. Missile and spacecraft structural uses are foreseen.

In an extension of Beryllium Corp.'s interests, the company announced that it is developing pyrolytic-graphite shapes for re-entry. A pyrolytic-graphite probe is 6 in. in diameter and 0.2 in. thick, with a 4-in. skirt, was exhibited. The company says it has made 14-in.diameter hemispheres of the material, and cone and nozzle shapes up to 20 in.

• **Stressed boron**—A potential competitor to fiberglass as a structural material was suggested by Texaco Experiment, Inc., Richmond. Under an Air Force contract, the company has prepared filaments of elemental boron having specific strengths up to 10.8 million in. and specific moduli up to 860 million in. The company is developing a continuous process for turning out these filaments and expects that they will be used in rocket cases, spacecraft and deep-diving submarines.

A Texaco spokesman told M/R that if the high-temperature properties of boron are retained when it is used as a filament winding, hotter rockets can be designed with correspondingly increased performance. Boron filaments are said to have the same strength as fiberglass—but four to five times its modulus of elasticity.

The company also has a potential semiconductor material that could be a boon to designers needing circuits able to operate in elevated temperatures.

Contained in a small glass vial at the Texaco Experiment display, the material was described as a crystal of elemental boron. About 2 cm long and 1 to 2 mm in diameter, it is representative of the company's recent work in producing the first sizable single crystal of the material.

Dr. Lloyd E. Line, head of exploratory research for the company, told M/R that early tests show the boron crystal retaining its electrical properties at temperatures higher than do semiconductor materials such as silicon and germanium. He added that a better indication of the semiconductor properties of boron would be available after a few more months of experimenting.

• **Space power**—Pressing its proposal for multi-KW fuel cells as an auxiliary power source for space vehicles, General Electric prominently displayed in schematic form a system that has direct application to *Apollo*. Based on the ion-exchange membrane fuel cell — which GE announced in 1959 — the power system is fueled by cryogenic hydrogen and oxygen.

The schematic shows the oxygen being used as both an oxidizer and a coolant, with the major cooling job being done by a liquid system connected to an external radiator.

It is known that GE is currently building an ion-exchange membrane fuel cell for testing in a 30-day satellite.

A 50-watt power range is being planned for the first fuel-cell test capsule, which will probably be launched in 1962.

The Martin Co. disclosed that it is doing research on an auxiliary nuclear power system able to generate electrical power in the SNAP-8 range at about one-third SNAP's specific weight.

Called "DCR-60," the unit is being designed to generate 60-KW of electrical energy for space applications. The system is potentially lightweight because it converts the nuclear reactor heat by thermionic techniques directly into electricity.

Martin believes the unit will be used as a power source in space laboratories, global communications satellites and electrical propulsion engines.

Martin project engineer Richard S. Strzelecki told M/R that a prototype of the DCR-60 could be built by 1967. He estimated its specific weight at 15.3 lb. per electrical kilowatt, which includes all components except shielding and structure. This contrasts with the estimated specific weights under the same conditions for SNAP-8—which for a 30-KW system is 50 lb./KW, and for a 60-KW system, over 40 lb./KW.

Strzelecki says DCR-60 could be extrapolated to 100 KW without a significant increase in overall system weight. He stated that whatever increase occurred would result only for an increase in radiator weight, because the reactor and generator would remain the same size.

The DCR-60 is a company-funded project which also includes basic development of a 300-KW thermionic system, expected to have a specific weight between six and seven lb./KW.

• **Dyna-Soar cooling** — A vapor-cooled system which would provide thermal protection to hypersonic glide vehicles during re-entry—while at the same time reducing the overall weight of the thermal shield—was described by William D. Allingham of The Boeing Co.

Citing the limited heat-absorptive capacity of metal heat sinks during the 30-minute aerodynamic heating re-entry periods, Allingham described a passive system in which a water-saturated wick absorbs the heats and vents the steam produced to the atmosphere through the outer insulation.

The system which could have application to *Dyna-Soar* consists of an outer re-radiating skin, a space vented to atmosphere, a perforated radiation shield, a layer of porous insulation and a heat sink consisting of water-saturated ceramic fiber wick.

During re-entry, the water in the wick is converted to steam and flows outward, cooling the outer skin. As the flowing steam cools the insulation, it becomes superheated, thus increasing the energy absorbed per unit mass of coolant.

(Continued on page 48)

Week-long orbit by '63 . . .

New Program May Fill Pre-Apollo Gap

by Hal Taylor

NASA is considering a new manned space flight program to fill the gap between Projects *Mercury* and *Apollo*.

The program, proposed by NASA's Space Task Group, is designed to put an American astronaut into orbit around the earth for as long as one week sometime in late 1963.

Its prime hardware will be an enlarged version of the *Mercury* capsule. It will weigh in the neighborhood of 5000 to 7500 lbs., far heavier than the 4000-lb. capsule now being used in the U.S. manned space flight series.

The bigger capsule will probably necessitate the use of a bigger booster than the *Mercury* program's *Atlas D* launch vehicle. There are persistent reports that the Air Force's *Titan II* ballistic missile will be tapped for the job.

In another manned space flight development, it was also learned that the space agency is pushing ahead with plans to modify current *Mercury* capsules to enable the U.S. to duplicate late next year the recent 18-orbit flight of the Soviet Cosmonaut Titov.

The changes are the result of a study made under a $90,000 contract by McDonnell Aircraft Corp., prime contractor for the *Mercury* capsule. The changes include the removal of certain auxiliary equipment from within the spacecraft in order to provide sufficient room to house a life support system capable of sustaining a U.S. astronaut for the 24-hour flight.

The removed equipment will be placed in the "adapter" which connects the capsule to the booster and will be jettisoned during the flight.

Both projects are the result of a NASA desire to bridge the "technological gap" between the *Mercury* and *Apollo* programs. *Mercury* is currently scheduled to terminate in mid-1962 with a series of three-orbit manned flights. A manned *Apollo* flight will not be flown until 1965.

Approval of the life support modifications for the 24-hour orbital flight is certain. Space Task group is already funded for the mission and work should begin in the near future.

• **Decision soon**—Top space agency officials also report that the "new program" is under active consideration by Administrator James E. Webb and other high officials. A final decision is due within a month.

An official said there are several proposals for an advanced program under consideration, but that if one is given the go-ahead, it is likely to be the one which involves an enlargement of the *Mercury* capsule, its technology and equipment.

Reports by Russian scientists at the International Astronautical Congress meeting concerning the alleged "seasickness of Titov during his flight have provided added incentive to supporters of the U.S. advanced program.

Certain U.S. space medicine experts said the "seasickness" might mean that there are real roadblocks in the way of a manned flight to the moon and back.

Space agency officials refused to comment officially on the subject. They point out that nothing is known as to Titov's physical condition before undertaking the flight. There is also the possibility that the conditions which produced the seasickness in Titov might not produce the same effect in another astronaut.

No true assessment can be made, NASA believes, until the U.S. puts a man into space for long periods of time.

This is just what the advanced program would do, its adherents contend.

It would permit the U.S. to orbit one—and perhaps two—astronauts for a period of five to seven days, just about the length of a manned moon flight. The long orbital flights would permit the U.S. to test the effects of long periods of zero gravity on man, without waiting for the development of the technology and materials needed for a moon spacecraft capable of returning to the earth from escape velocity. ¤

First Saturn Launch Is Fateful Step

THE U.S. SPACE program reaches a significant milestone late this week with the first attempt to launch the *Saturn C-1* booster—America's and perhaps the world's largest space launch vehicle.

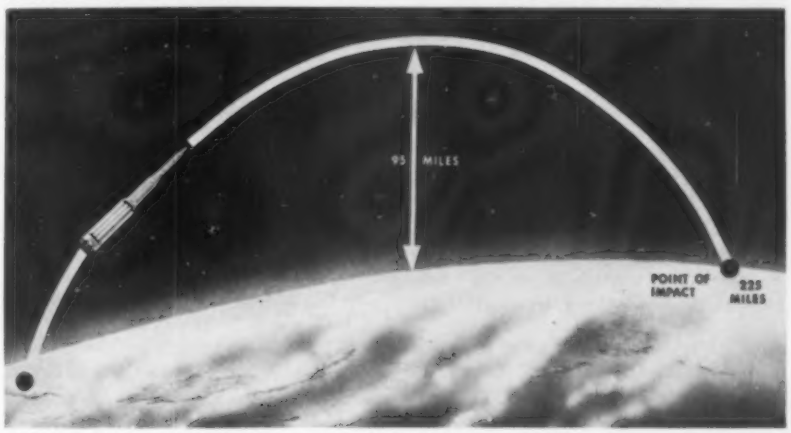
If successful, it will be a big stride forward for the U.S. space program and this country's chances of beating the Russians to the moon. Technical difficulties with one of the eight H-1 engines of the first stage delayed a scheduled launch earlier in the month. Blastoff is now scheduled for Oct. 20.

NASA announced that the main purpose of the first flight is to test the propulsion system of the booster, verify aerodynamic and structural design of the entire vehicle, and prove the design concept and function of the ground support and launching equipment.

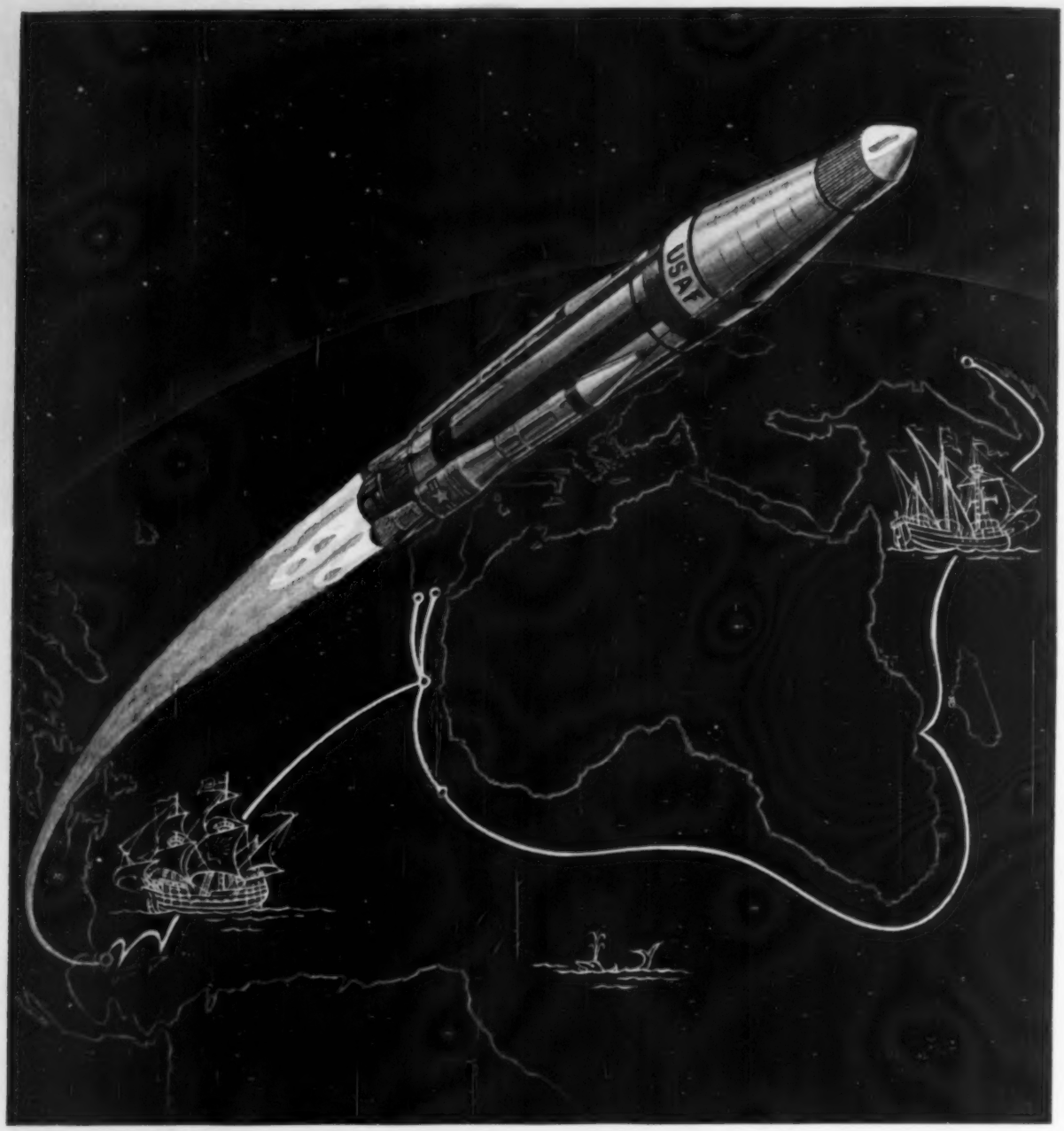
For the first launch, only the first stage will be live. It will propel two inert upper stages which will be ballasted with water to simulate the weight of the live stages.

The first flight will have a short trajectory of 225 statute miles and a peak altitude of 95 miles. Duration of the flight will be eight minutes and the top velocity will be 3700 miles per hour.

(Continued on page 47)



NEWLY RELEASED drawing shows planned flight path of first Saturn C-1 launch.



Arma navigates new routes

Navigating with cross-staff and primitive compass, Prince Henry's Portuguese pilots took more than 80 years to find a route around Africa and reach India. The Spaniards took another 20 years to cross the Atlantic and reach the shores of Florida.

Today, missile-borne inertial guidance can navigate such distances in a matter of minutes and pin-point targets nearly half-way around the world. Other advantages of inertial navigation are immunity to outside interference, all-weather capability, salvo firing, and a minimum of ground equipment.

Arma, designer of America's first inertial guidance of intercontinental range accuracy, has these systems in full production with on-schedule deliveries. Although specified for the Atlas missile, the Arma system is equally adaptable to other aerospace programs and space exploration projects.

At Arma, research programs currently are exploring smaller, supersensitive devices for future generations of missile and space guidance systems. Arma, a division of American Bosch Arma Corporation, Garden City, New York. . . . The future is our business. 8321

AMERICAN BOSCH ARMA CORPORATION

NOTICE TO SUBSCRIBERS

This card is not a renewal notice. It is for the use of new subscribers only. If you already subscribe, please pass this information on to an associate in the industry.

Receive your personal copy of missiles and rockets every week

Examine this copy of **Missiles and Rockets,** The Missile/Space Weekly. You will quickly see why M/R is relied upon by subscribers for fast-breaking news stories and complete technical editorial coverage of electronics, guidance, propulsion, advanced materials, ASW and ground support equipment. If you are not now a regular subscriber, it will pay you to have your personal copies of M/R delivered regularly to your home, office, or laboratory on a weekly subscription basis.

FILL OUT AND DETACH CARD BELOW

ENTER MY [NEW] *SUBSCRIPTION TO*

missiles and rockets

☐ **3 YEARS $10**
☐ TWO YEARS $8.00
☐ ONE YEAR $5.00

ALL SUBSCRIPTIONS TO MISSILES AND ROCKETS INCLUDE THESE SPECIAL ANNUAL ISSUES:

March
Research and Engineering Issue

July
Missile/Space Encyclopedia Issue

November
National Aeronautics and Space Administration Issue

Please indicate your principal field of work :

- ☐ Missile frames
- ☐ Power plants
- ☐ Support systems
- ☐ Components
- ☐ Consultants, R&D
- ☐ Missile base/range operations
- ☐ Propellants
- ☐ Metals, Materials

Rates shown above are for U.S., Possessions, Canada and Postal Union Nations. *Other countries:* ☐ 3 years $35 ☐ 2 years $25 ☐ 1 year $15

☐ Send bill later ☐ Check enclosed ☐ Purchase order attached

NAME _____

TITLE OR POSITION _____

STREET ADDRESS _____ ☐ *HOME?* ☐ *BUSINESS?*

CITY _____ *ZONE* _____ *STATE* _____

COMPANY NAME _____

DIVISION _____

Subscriptions are limited to those in the missile/space industries or in related areas. Please fill out this card completely. Additional postage is required if mailed outside the U. S. A.

These missile engineers already know the value of missiles and rockets . . .

"I want to keep up with the industry in which I am engaged. This publication contains information that I do not get elsewhere."
—Analytical Engineer, Rocket Equipment

"I like the magazine. It is different; it covers everything in as few words as possible."
—Engineer, R & D, Missiles, Radar Communications

"It keeps me up to date on new developments. All the information is condensed and you do not have to wade through a thousand pages to get a nickel's worth of information."
—Project Manager, Consulting Engineers

FIRST CLASS
Permit No. 2455-R
WASHINGTON, D. C.

BUSINESS REPLY MAIL
No Postage Stamp Necessary if Mailed in the United States

POSTAGE WILL BE PAID BY

missiles and rockets
THE MISSILE/SPACE WEEKLY
1001 Vermont Avenue, N.W.,
Washington 5, D. C.

Sergeant to Give Army Tactical Boost

Long-awaited inertially guided system, operational in '62, will be far more mobile than old Corporal

by James Trainor

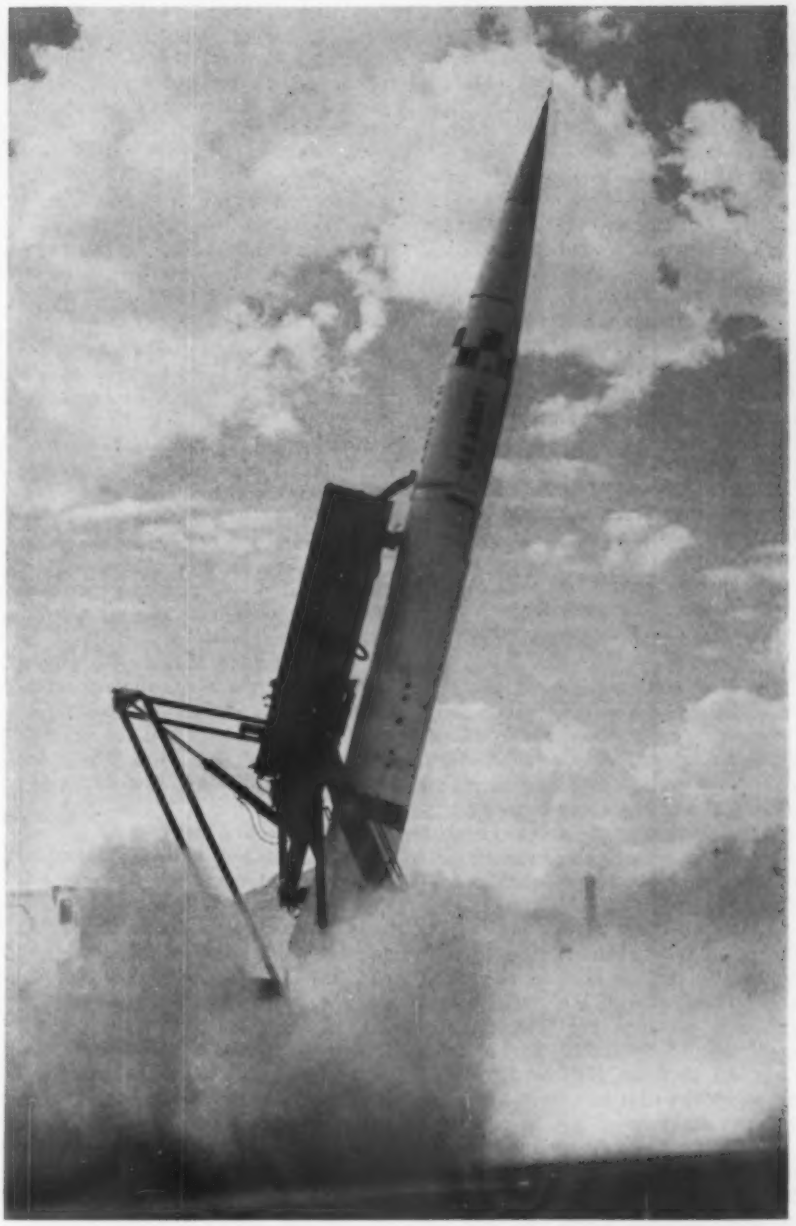
SERGEANT—the Army's mobile replacement for the *Corporal* tactical missile—will provide the army or corps commander with at least an order-of-magnitude improvement in system effectiveness over its lower-ranking predecessor.

The missile is well along in production at Sperry-Utah, prime for the system, and scheduled to be operational next year. It successfully completed its R&D test-firing phase with a series of shots ending at White Sands Missile Range, N.M., two weeks ago. The Army plans more flight tests of production models.

• **The difference**—A quick comparison of the two systems gives clear evidence of *Sergeant's* superiority over the more complicated *Corporal*. The older weapon uses liquid, hypergolic propellants, while *Sergeant* employs a stable, long-shelf-life solid which eliminates the time-consuming, dangerous fueling operation and its demands for specially trained personnel, protective clothing and vehicles.

Because it was developed during the infancy of missile technology, the *Corporal* is saddled with a radio command guidance system which requires heavy, complex ground support equipment. By contrast, *Sergeant* is equipped with inertial guidance and needs only the checkout panels used to insert firing data and to test and monitor the system's status.

Probably the greatest asset of the new system, however, is its extreme mobility. Using only four vehicles, *Sergeant* closely approaches the Army's



SERGEANT USED IN FINAL shot of R&D test-firing series at White Sands Missile Range, N.M., recently. Sperry-Utah and Army personnel carried out the launch.

"shoot and scoot" philosophy. In addition, it is air-transportable in Phase II in airborne operations by C-130 type aircraft.

The overall reduction in both the size and the amount of equipment has made the *Sergeant* not only more mobile but also more reliable. The maintenance concept—based on plug-in replacement of assemblies and subassemblies—has also contributed significantly to the flexibility and responsiveness of the system.

• **How it began**—Even while the *Corporal* was being developed back in 1950, the Army realized the need for a second-generation system to replace it. However, the project languished until, in 1953, Jet Propulsion Laboratory submitted to the Army Ordnance Corps the preliminary design of a solid-propellant missile.

It was not until January, 1955, however, that the Army approved JPL's proposal and gave it an R&D contract for the system which was to be developed under the technical supervision of the Army Rocket and Guided Missile Agency—at that time Redstone Arsenal.

To preclude time-consuming delays in changing from an R&D contractor to a production contractor, the Army selected the Sperry Gyroscope Co. to work with JPL on missile development. When the Cal Tech organization was transferred to NASA on July 1, 1960, Sperry assumed responsibility for the R&D program. The final management change came a month later, when the Army made the Army Ballistic Missile Agency responsible for technical supervision of the *Sergeant* project, replacing ARGMA.

• **Four sections**—The 34½-ft. 31-in.-diameter missile is broken down into four basic sections: Warhead, Guidance, Motor, and Control Surface. All of the sections are transported in individual containers built in such a way that missile components can be checked out without removing the missile sections from or even opening, the container.

After checkout at the launch site, the boom on the launching station is used to mate the sections; electrical connections between the warhead and guidance sections are automatically made through the use of ram-home fittings. Attached last, the interchangeable fin assemblies slide into place over shoe and slot brackets.

After the firing data is inserted into the firing-set computer, fed from there into the missile and rechecked on a go-no-go indicator panel, the missile is elevated to five degrees from the horizontal and slewed to the proper firing azimuth. Then it is elevated to 75 degrees, the countdown is automatically completed and the missile is fired. A precise theodolite determines the firing azimuth by autocollimation.

• **And away she goes**—In flight, the azimuth, roll and range are controlled by control surfaces at low altitudes, jet vanes in the thinner atmosphere, and drag brakes.

Unlike the liquid-fueled *Corporal*, the 50,000-lb.-thrust *Sergeant* motor cannot be cut off by a valve in the propellant stream. Therefore, after various methods of cutting off the motor were studied, drag brakes—located at the rear of the guidance section—were installed to control the velocity and, therefore, the range of the missile. Development of this system caused some problems; however, according to project engineers, these have been satisfactorily solved.

Reportedly, the missile has the same range as *Corporal*—80-110 miles, and it carries a similar, approximately 1500-lb., conventional or nuclear payload. The missile weight at liftoff is set at around 10,000 lbs.

• **Ground support** — Designed to meet an estimated 30-minute reaction time, the *Sergeant* GSE has been designed for transport on standard Army trailers pulled by standard tractors. Other than the missile and the storage containers, the support equipment consists of the launching station, Organizational Maintenance Test Station (OMTS) and the Field Maintenance Test Station. All of the elements necessary to fire are contained in four tractor-trailer loads.

The launching station—the largest and heaviest piece of support equipment—mounts the erector-launcher, a gas turbine generator set, the azimuth orientation unit, an azimuth ring for slewing the missile, a blast deflector and leveling jacks.

When the unit enters a firing position, the launching station is uncoupled from the tractor and the gas turbine is started—reaching full speed in 30 seconds. The outriggers are emplaced, the circular aluminum blast shield dropped and, finally, the superstructure is raised and the boom extended.

The boom is used to lift the missile sections from their coffin-cover containers and assemble them. The missile is now ready for the final launch preparation described above.

The OMTS provides checkout and first and second-echelon maintenance to the firing unit in a service area adjacent to the launch site. Automatically self-checking, the test station determines if the missile sections are performing properly. In the event of a failure, the test stops and the fault is isolated to a particular unit.

A jib-crane lifts the faulty section from its container to the maintenance area inside the van. There the defective assembly is replaced from the spare load carried on the vehicle.

Further to the rear, in an Ordnance direct support unit, is located the Field Maintenance Test Station (FMTS) which provides support to several *Sergeant* batteries. Capable of performing the same operations as the OMTS, the field maintenance station has the added capability of further isolating the fault to the subassembly level and repairing the assembly from its greater variety of tools and spares.

• **Tests cover all angles**—As early as 1958, the Army began a comprehensive environmental test program to insure that the *Sergeant* system would perform under all conditions of terrain and weather. That first four-week test with an experimental system at the Army's Yuma desert test station proved that the *Sergeant* would provide the mobility and ruggedness that was required. In addition, the system has undergone gruelling tests in the climate chambers of Sperry's Utah plant.

Flight tests—initiated only one year after the development contract was approved—proved the feasibility of the *Sergeant* concept. Further flights in 1958-59 resulted in some redesign of the system, but again basically proved the soundness of the system approach.

Subsequent firings have progressively integrated the operational prototype support and maintenance equipment to insure system compatibility. The firings leading up to the successful, final R&D firing included firings under blackout conditions, sustained rate of fire exercises and a mountaintop-to-plains firing to prove the accuracy of the fuzing and arming system even at wide variations of altitude between the target and launcher.

However, the flight testing has not ended. The Army plans to continue firing in order to verify the performance of the production missiles and to insure that they meet the rigid military characteristics set forth for the tactical system.

Once the Army is satisfied that *Sergeant* really outranks its veteran *Corporal*, the system will begin to replace *Corporal* units stationed in Europe and the United States. This changeover—scheduled to begin next year—promises to give the Army a mobile flexible atomic punch to back up its combat divisions. ⌗

A cross-section of the 40 subsystems incorporating 3500 electronic parts which go into TIROS III are framed by two satellites. All components must be thoroughly tested, precisely integrated and must function perfectly if the satellite is to perform successfully.

NASA's Hurricane spotting TIROS III maintains projects' fine performance record

With the successful launching of TIROS III, meteorologists for the first time will see the total cloud formations and measure the radiative energy balance of hurricanes which plague the eastern coast of North and Central America each year. For TIROS III was launched at this time for precisely this purpose. From information gained from TIROS III, meteorologists may learn much more about the birth and life cycle of tropical storms.

TIROS III DESIGN

Although the spacecraft configuration is essentially the same as the previous two highly reliable TIROS satellites, TIROS III has two wide-angle cameras and the National Aeronautics and Space Administration has placed new omnidirectional IR sensors aboard to measure thermal radiation from the earth and sun.

THIRD OF A FAMOUS FAMILY

TIROS III is the third of a highly successful series of experimental weather satellites which were developed, along with the associated ground equipment, for the NASA, under contract with the Goddard Space Flight Center, by RCA's Space Center. All of them have established "firsts" in the United States' space program.

TIROS II established a longevity record for a complex satellite. Still operating after nearly eight months and over 3300 orbits, TIROS II has transmitted over 34,000 photographs to the ground. Aside from its impressive meteorological achievement, historians may well point to this long-term performance as the first to prove that a satellite system could operate reliably for so many months in a space environment thus proving the feasibility of operational satellites.

TIROS I was the first satellite, carrying advanced television equipment, which sent photographs of the earth's cloud cover to meteorologists. From TIROS I's 23,000 photographs, meteorologists found that satellites could be used for weather observation and analysis. The pictorial information is particularly useful in the two-thirds of the world from which few or no weather observations are now available.

CONNOTATIONS FOR THE FUTURE

The TIROS series has proved beyond a doubt that the peaceful uses of space will benefit all mankind. Six nations participated in the utilization of information from TIROS II and more will take advantage of TIROS III. RCA is also already at work on the camera systems and space power supply for NIMBUS, the next generation of meteorological satellites.

If you are a professional physicist, engineer, or mathematician and interested in participating in such challenging projects and stimulating team efforts, contact the Employment Manager, RCA Astro-Electronics Division, Defense Electronic Products, Princeton, N. J. All qualified applicants are considered regardless of race, creed, color or national origin.

RCA®

The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

A lot of jobs—especially in missiles—need room to complete. It takes inner space to prepare for outer space. It takes skills and long experience to work with metals in the large way some of your jobs require.

General American's Plate & Welding Division has the space, the skills and the experience you need, whether your problem is one or a dozen special pieces, or a continuous operation involving thousands of units.

General American has produced lox vessels, radiation shields, atomic waste evaporators and missile equipment components. We are known around the world for the tanks we have fabricated and erected—tanks for storage of petroleum products, acids, chemicals and water; tank cars for transportation of any kind of liquid. We are constantly at work on projects that involve cutting, forming, milling and stress relieving of large metal structures. Our background in aluminum and alloy steels is considerable.

When a job requires custom fabrication of metal—any metal—we generally can handle it faster and better than any one else. We would like to work for you.

Plate & Welding Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street • Chicago 3, Illinois

PLATE & WELDING DIVISION GENERAL AMERICAN TRADE MARK

Offices in principal cities

Circle No. 8 on Subscriber Service Card

Technical Countdown

ASTRONAUTICS

Apollo to Use Fuel Cells

Word from contractors working on *Apollo* proposals is that NASA has told them the lunar spacecraft will use fuel cells for auxiliary power—despite opposing arguments from manufacturers of cryogenic units. Industry spokesmen also discount the possibility of using a regenerative system. A fuel-cell APU has not been flown as yet but NASA expects that before *Apollo* is ready, fuel-cell technology will have been tested in earth orbit. General Electric's Missile and Space Vehicle Dept., for one, has an Air Force contract calling for this.

PROPULSION

Firings in the West

Douglas Aircraft's Astropower subsidiary has test-fired successfully a 1500-lb.-thrust rocket engine which it has proposed as a vernier unit for *Apollo*. The engine uses nitrogen tetroxide and a mixed amine fuel.

The second Tory II A-1 power run in 10 days has been completed at the AEC's Nevada Test Site. The reactor was operated for about one minute at temperatures over 2000°F by Lawrence Radiation Lab scientists. Results are said to be satisfactory. The tests are part of an investigation of the potential of a nuclear ramjet for Project *Pluto*.

A flightweight, ablative-cooled thrust chamber assembly for liquid rockets has been test-fired by United Technology Corp. The unit has been continuously fired for 4.5 minutes with a 2200-lb.-thrust engine. Accumulated time with re-firings has reached 7.2 minutes. The chamber eliminates the need for complex cooling tubes.

600-lb.-Thrust Variable Engine Developed

A hypergolic engine capable of a nominal 600-lb. thrust has been developed by Moog Servocontrols in cooperation with Marquardt and Naval Ordnance Test Station, China Lake, Calif. The new engine has been operated with pulsed inputs at a repetition rate up to 130 cps. Pulse amplitude during these tests required that the engine vary ±300 lbs. The engine can be operated in a proportional mode, and its thrust can be varied in response to input signal from zero to maximum thrust levels. Suggested uses, says Moog, include cushioned landings, mid-course guidance, and rendezvous in space.

ADVANCED MATERIALS

Cryogenic Sampler Operational

An upper-atmosphere collecting system has been perfected by Aerolab. The cryogenic unit reduces the gases collected in volume by cooling to liquid hydrogen temperatures. In a recent 50-mile-high firing, the unit collected everything in 21,000 cu. ft. of air. The sample returns in the form of a frozen sludge and the system can contain the high pressure as it warms up and the sample returns to the gaseous state.

Sound Facility Completed

Goodyear Aircraft Corp. is exploring the destructive effects of sound in a new million-dollar facility. One noise-maker, a kind of a massive hi-fi set, can range through frequencies from 37 to 10,000 cycles or higher in a single test. The unit has the ability to create noise of differing types and intensities, avoiding the penalties of a direct system. Time tests have run as long as 8 hours. In addition to two square chambers, Goodyear has a reverberant chamber to give its researchers multi-directional capabilities.

SPACE MEDICINE

BIOS Vital for Space Travel

NASA's *BIOS-1* capsule is slated for launch from PMR on Nov. 15. A follow-on program to *NERV*, the probe will have a 1015-n.-mi. downrange. (The former *NERV* facility will be used for *BIOS-1*, but it's hoped that the *Scout* site will be utilized for later launches.) *BIOS (Biological Investigation of Space)*, will carry numerous animal test samples. The tests are considered vital because *NERV* results showed a neurospora mutation rate of over 30 times normal; further investigation is required to determine the reasons for this.

ELECTRONICS

Lunar Power Package Produced

A nuclear thermoelectric power system which uses the spontaneous decay of a radioisotope to produce heat and then electricity has been demonstrated by Westinghouse Aerospace. The system is designed to produce 50 to 60 watts for three months' life on the moon's surface. The heat transfer medium is liquid metal.

Trend Toward Bigger Antennas Continues

Communications for planetary vehicles will be handled by JPL's Deep Space Instrumentation facility. It will also handle program support for *Apollo* and other manned lunar flights. Big future changes in this area are expected to be evolutionary, with accent upon increased ground transmitter power and larger antennas—both on the ground and on space vehicles. Vehicle power will probably remain about the same, with a maximum of 150 watts available in space probes and 10 watts for lunar-landing vehicles.

S-27 Launch Due Next March

First Canadian-built satellite will be launched from the new *Thor* pad at Vandenberg AFB in March, 1962. This will be the *S-27*, a swept-frequency top-side sounder which will be used to study electron density in the atmosphere at altitudes between 300-1000 kilometers. The satellite will measure 42 in. dia. by 34 in. high. Weighing 275 lbs., it will be put into 625-n.-mi. circular orbit. Signals transmitted from the satellite will be received and re-transmitted back. Time delay measurements will be used to determine electron density.

No Rebound 'Til '63

Project *Rebound* is slated for launch from Pt. Arguello in the second half of 1963. It will consist of three containers and three passive communications balloons boosted by *Atlas-Agena-B* into an elliptical orbit. Containers for balloons will be tracked for about 20 hours by ground stations, in order to adjust preset nominal timers which will open containers and place each balloon into orbit at the proper time with a 120-degree spacing.

Air Bearings Enhance Gyro Testing

Fluid-bearing suspension of turntables has brought order-of-magnitude range increase

by Goddard C. Parsons and John A. O'Shea, Sr.*

PRECISE PERFORMANCE evaluation of inertial guidance systems and their components has been limited in the past by the operating characteristics of the test equipment itself.

In particular, the use of mechanical anti-friction bearings in rotary test turntables has seriously handicapped determination of minimum residual drift rates of integrating type gyroscopes.

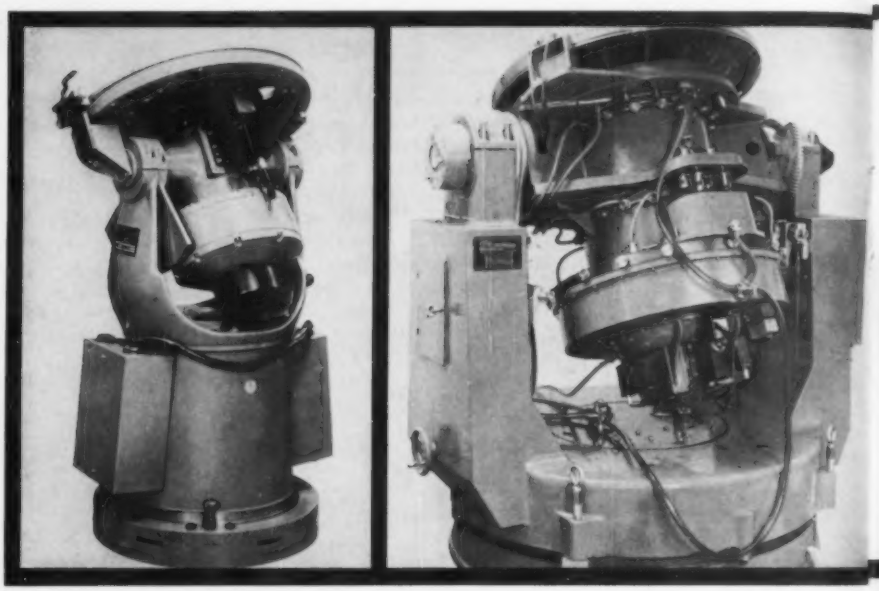
Recent developments in air-bearing suspension techniques, Dunn Engineering Corp. engineers believe, now make it possible to extend test-table range capability by an order of magnitude.

The advent of inertial-grade gyros made it necessary to design and build specialized test instruments capable of accurately measuring minute, non-compensatable residual drift rates. Residual drift is the prime measure of gyro quality and, as such, depends directly upon the degree to which the effects of gimbal friction and mass unbalance can be eliminated.

When friction is not a limiting factor, gyro performance is limited by mass unbalance.

The development during World War II of the floated rate-integrated gyro radically advanced the reduction of gimbal friction. As further refinements in manufacturing techniques were made, the need for more precise test equipment became increasingly apparent. As in all areas of measurement, the criterion for satisfactory instrument design is that the test gear performance be at least an order of magnitude better than that of the test specimen.

Of the several gyro test methods developed for measuring gyro drift rates, the most commonly accepted one was that employing the servo-test turntable. This instrument is a tiltable, single-axis table on which is mounted the test specimen. It is supported by anti-friction bearings and servo-driven from the gyro-output signal.



In this method of testing, the table is slaved to the specimen by means of the closed-loop servo system. Therefore, it becomes evident that the faithfulness with which the table follows the gyro is dependent upon the quality or performance characteristics of the turntable itself. Of major concern is friction inherent in the axis-support bearings.

Advancement in table design has centered around attempts to minimize friction or, more importantly frictional uncertainties in the bearings. Ten years ago machines fitted with conventional ball or roller bearings were adequate for measuring drift rates of 0.1°/hour; today they are no longer suitable for conveniently evaluating gyros below 0.01°/hour drift.

Successful application of fluid-bearing suspension to turntable design has made it possible to extend the range of performance by an order of magnitude. In particular, the use of air- or gas-bearings makes practical the manufacture of high-performance test tables capable of testing not only the most up-to-date gyros but entire inertial platforms.

• **Metal bearing limitations**—Originally developed by the Instrumentation Laboratory of Massachusetts Institute of Technology, the widely-known type "D" table employs conventional roller or ball bearings to support the main table axis. Modifications of the basic design have been produced by several manufacturers to meet the rapidly changing specifications caused by development of higher-performance gyros.

*Mr. Parsons is manager, Mr. O'Shea a mechanical design engineer, in the Inertial Products Dept. of Dunn Engineering Corp., Cambridge, Mass.

Improved gyro performance has imposed new and more stringent requirements on this type of test table.

The D-type table is seriously limited by stiction (static friction) and by the variation in frictional torque caused by the mechanical bearings used to support the main turntable shaft. Frictional torque variation introduces "noise" into the servo loop, creating tracking errors which prevent the table from truly "following" the gyro. As a result, the test data usually represent a composite of both gyro and table performances.

• **Oil bearing an improvement**—To solve this problem, the Cambridge Engineering Laboratory of Dunn Engineering Corp. developed a compensated-fluid bearing and incorporated it in a large equatorial platform (Model T818) which was introduced commercially in 1957.

The use of pressurized oil-bearings in this massive turntable made it possible to achieve precise orientations and frictionless rotation even with loads in excess of 500 lbs. By employing such bearings it was possible to eliminate the metal-to-metal contact of conventional bearings.

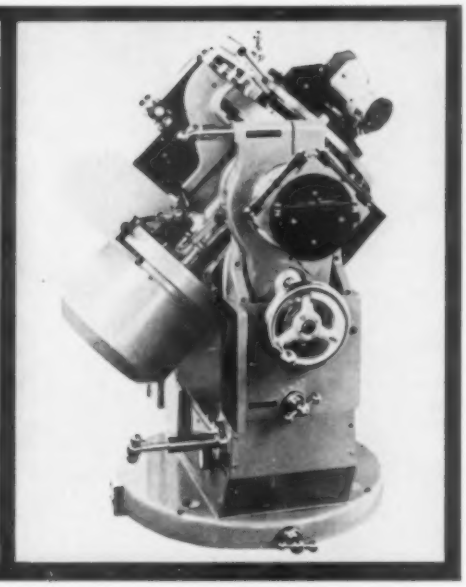
Also, the resulting accuracy of rotation was dependent only on the location of the mean surfaces. As a consequence, the fluid bearing, or film, served to average the geometry of bearing surfaces, resulting in precise location of its center or rotation.

Without metal-to-metal contact (even when not rotating), the main resistance to turning is that due to viscous shearing of the fluid in the gaps. Using light viscosities and low rotational speeds, these shearing forces are low for the bearing sizes involved, and are constant at fixed speeds without exhibiting any "slipstick" characteristics present even with the best ball or roller bearings.

Non-uniform torques in fluid bearings, Dunn believes, are in general due to changing inertia or momentum forces in the fluid, and are much smaller than the random torques found in mechanical bearings.

In current applications, oil-bearing turntables are used primarily with complete navigational systems to check alignment of their inertial components and to observe gyro and platform drift characteristics.

EVOLUTION of gyro-test sidereal turntables is shown by these typical instruments developed by Dunn Engineering Corp. From left to right: standard type-D using roller or ball bearings for main table axis support (Model T800-D); fluid bearing Model T818; and the newest air-bearing servo/rate table (Model T900).



• **Air bearing preferable** — New gyro testing requirements, necessitated by the development of still higher performance gyros, prompted Dunn to investigate the use of air-film bearings. This resulted in design and development of vastly improved turntables using gas-lubricated bearings.

Air is preferable to oil, researchers believe, for several reasons:

1) There is no problem of fluid recirculation—air is exhausted into the atmosphere, continuously purging the bearing system.

2) Torques caused by non-uniform inertia or momentum-forces of the fluid are an order of magnitude less than for oil.

3) Viscous drag torques are much lower.

4) The dynamic characteristics of air are such that it is insensitive to variations in temperature. Conversely, small variations in oil temperature may produce substantial random effects on bearing behavior, even in a capillary-compensated oil-bearing design.

• **Early problems**—Initial experiments with air bearings included the investigation of designs using small grooves or recesses which create constant-pressure pockets. These help to increase the load-carrying capacity of the bearing. Such a design tended to self-oscillate or "flutter" except under certain restrictive conditions.

The so-called "air-hammer" phenomenon found in this type of bearing is due to an inherent instability caused by the pockets or recesses. When these self-oscillations were eliminated through design changes, the bearings were still only marginally damped.

The earlier investigations led to experimentation with inherently-compensated air bearings which avoided the use of recesses and were basically stable. Tests proved the design to be well suited to turntable applications. It has high stiffness and high relative stability; it is positively damped and not susceptible to the "air-hammer" experienced in earlier designs.

In its final configuration, the air bearing is similar to a conventional sleeve-type journal bearing with a thin film of air separating the fixed and rotating parts. The air itself is maintained by supplying air through upstream restriction or orifices so spaced and of such size as to provide controlled flow to the bearing gap.

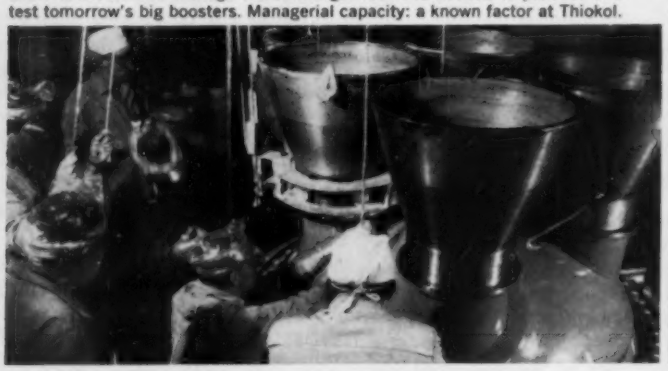
By using a film of air to separate the movable and fixed bearing surface, Dunn developers found that "stiction" is avoided and viscous drag is negligible. The surfaces are kept clean or purged due to the gas flow through the bearing. The gas itself may be either air supplied from an ordinary shop air line (80-120 psi) or dry nitrogen from a high-pressure compressed-gas chamber.

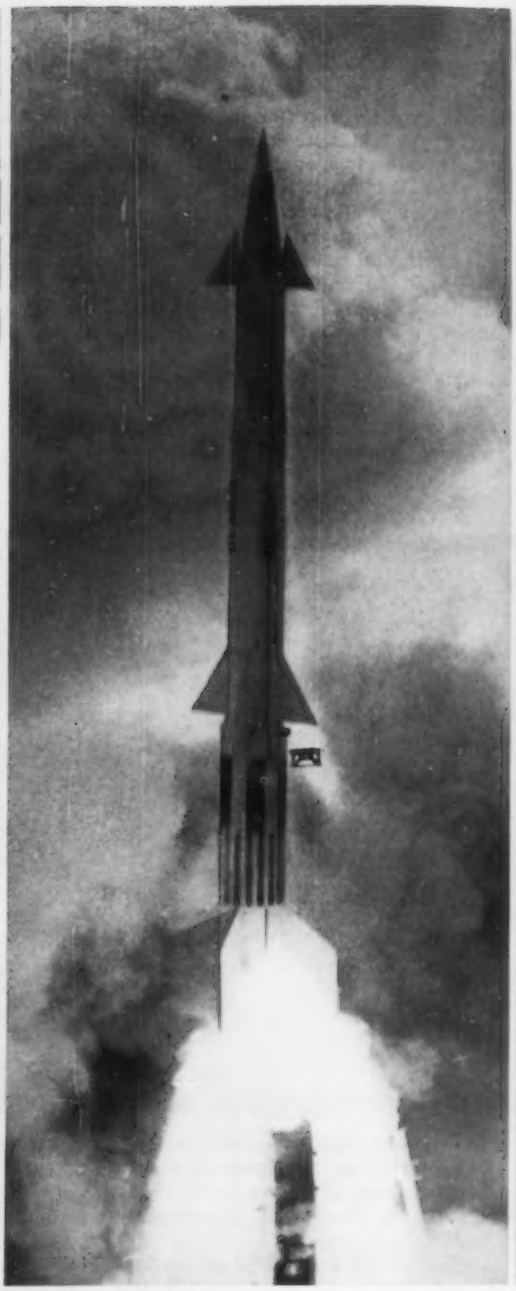
• **Cost vs. performance**—The cost for air-bearing tables is comparable to oil-bearing types and is approximately 25% more than for roller or ball-bearing types. The demands of inertial-grade gyros now hitting the market—gyros with drift rates of the order of 0.001°/hour—can be met only with fluid bearings, however.

Bearings of traditional design will find less and less use because of the advantages of the air-bearing—low friction, maximum life due to the self-purging design, and reduced maintenance. ⌗

Thiokol's Wasatch Division... now turning out the largest flight-tested solid rocket engine of record, Minuteman first stage... is capable of producing engines of satellite size. Plant growth: from 17 to 120 buildings since 1957.

Experience in developing and managing facilities of this size is required in order to create and manage the still larger facilities needed to produce and test tomorrow's big boosters. Managerial capacity: a known factor at Thiokol.



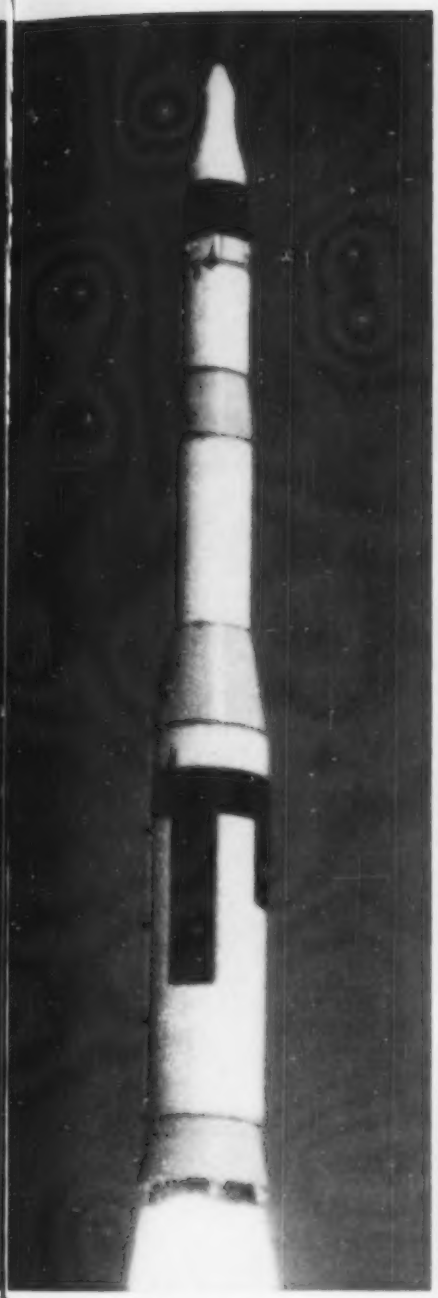


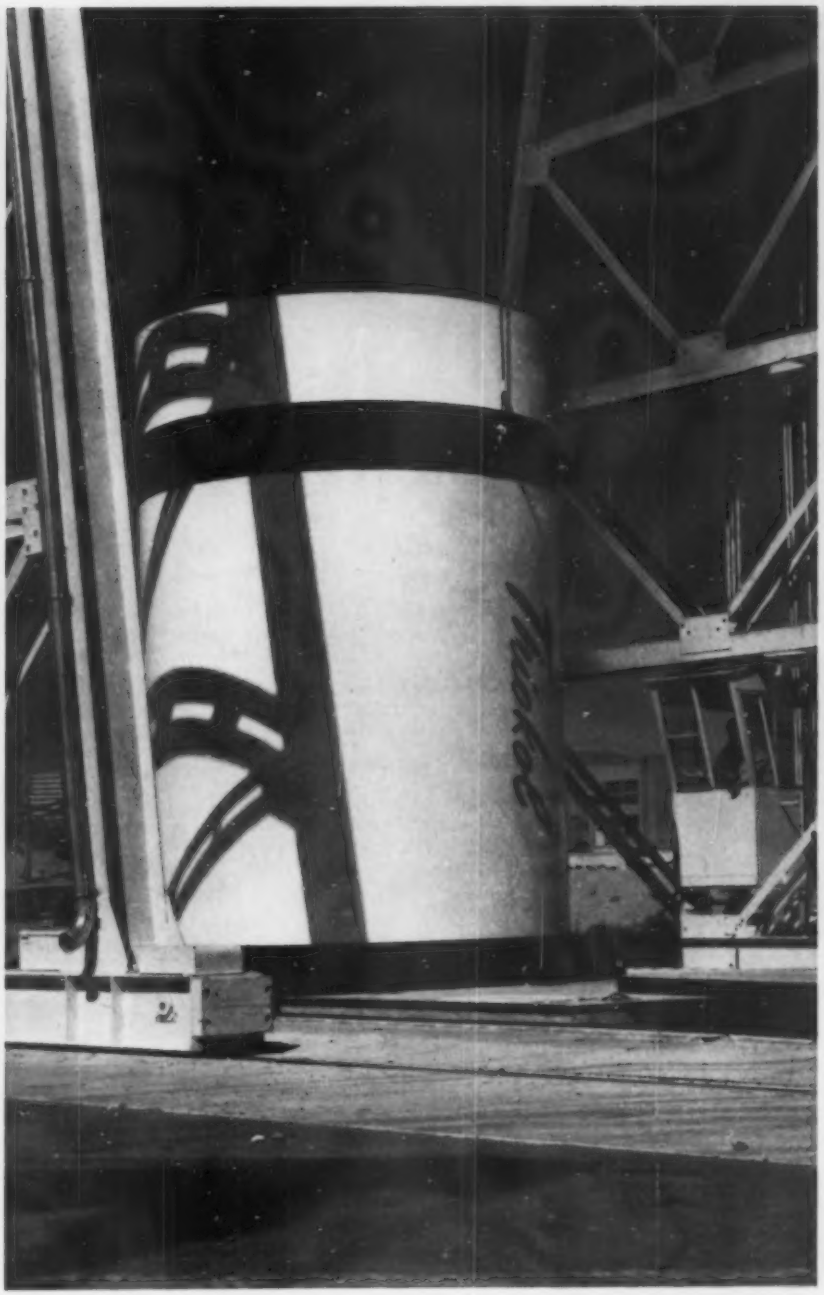
BENCHMARKS in the

SOLID STRIDES TOWARD SPACE BOOSTERS

As early as 1952, Thiokol recognized the need for the economy and reliability of giant solid rockets in our country's defense and space efforts. In 1956, the Corporation allotted and invested millions of its own funds in research and production facilities to meet these requirements and assigned its skilled management, engineering and technical teams to man plants and lab-

THIOKOL CHEMICAL CORPORATION □ Bristol, Penna., Rocket Operations Center: Ogden, Utah





science of rocket propulsion

oratories. Having moved with rocketry through early frontiers, Thiokol is well prepared and well equipped to meet the challenge of the new frontier. □ Thiokol has designed, developed, and produced the most powerful and also the largest flight-tested solid rocket motors on record... Zeus, with 450,000 pounds thrust, and the first stage engine for Minuteman.

Thiokol®

CHEMICAL CORPORATION

FIRST IN ROCKET PROPULSION

Engineers. Scientists. Creativity is always welcome. Perhaps there's a place for you on the Thiokol team. An equal opportunity employer.

Circle No. 9 on Subscriber Service Card

We promise you a reply within one week.

new openings in space age electronic projects

Hughes Aerospace Engineering Division offers experienced graduate engineers and physicists a choice of many openings on Hughes projects which include:

- Surveyor (soft lunar landing)
- Polaris Guidance
- Satellite Communications
- LINAC and MOBOT*
- COLIDAR (coherent light detection and ranging)
- Infrared Search Systems
- Advanced Air-to-Air Missiles
- ASW Data Processing Systems

Training and experience should be applicable to the research, development, design and testing of advanced electronic equipment for use in space vehicles and supersonic military aircraft; in solid state physics, nuclear electronics, industrial dynamics, and related areas.

Use of the following form will, we hope, reduce to a minimum the inconvenience of submitting an employment inquiry, yet will still permit us to give you a reasonably definitive reply.

Please airmail resume to:

Mr. Robert A. Martin, Supervisor, Scientific Employment
HUGHES AEROSPACE ENGINEERING DIVISION
Culver City, California

HUGHES

HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS

An equal opportunity employer.

*TRADEMARK H. A. C.

NAME_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

COLLEGE_____ DEGREE_____ YEAR_____

I am interested in one of the following types of assignments:

☐ RESEARCH ☐ PROTOTYPE DESIGN ☐ SYSTEMS ANALYSIS ☐ OTHER:
☐ DEVELOPMENT ☐ ADVANCED TECHNICAL PLANNING ☐ SYSTEMS DESIGN ☐ _____

I have had professional experience in the following specific areas:

☐ CIRCUIT ANALYSIS AND DESIGN ☐ STRESS ANALYSIS ☐ R-F CIRCUITS ☐ ELECTRO-MECHANICAL DESIGN
☐ DIGITAL COMPUTERS ☐ INDUSTRIAL DYNAMICS ☐ RELIABILITY ☐ OTHER:
☐ GUIDANCE DEVICES ☐ INFRARED ☐ INERTIAL GUIDANCE ☐ _____
☐ MICROWAVES ☐ SYSTEMS ANALYSIS ☐ INSTRUMENTATION ☐ _____

I have had a total of_____years experience.

SYNCOM To Benefit From Ground Control

THE PROJECT SYNCOM communications satellite will feature a new simplified control system which NASA officials believe is a significant breakthrough in the art of controlling light spacecraft.

Prim. advantage of the system is that it is controlled from the ground—removing a great deal of complex mechanism from the spacecraft itself.

The new system, designed by Hughes Aircraft, prime contractor for the project, was disclosed as NASA released preliminary details of the satellite's construction and operation.

The experimental active repeater communications satellite will be launched from Cape Canaveral late next year into a 22,300-mile orbit synchronous with the earth's rotation. A three-stage *Delta* vehicle will be the booster.

The satellite will be cylindrical—25 in. high, 28 in. in diameter—and weigh about 55 lbs., excluding an attached solid rocket motor which will be used to inject the spacecraft into its orbit.

For the first series of *SYNCOM* satellites, the orbit will not be stationary. Instead, the satellite will move in an elongated figure-eight pattern, 33 degrees north and south of the equator, over a given longitude above the Atlantic Ocean for its 24-hour period.

• **New controls**—To achieve this orbit, properly orient the spacecraft, and maintain its attitude, Hughes developed the special control system.

The system employs two nitrogen jets. One is located on one end of the spacecraft about 12 in. to one side and thrusts parallel with the spin axis. This will be used to insure proper orientation for the spacecraft's estimated one-year life.

The other jet, located at the side of the cylinder, thrusts perpendicular to the spin axis. This will be used to provide precise adjustment of the orbit.

Solar sensing cells, located on the side of the cylinder provide information through telemetry, in real time, from which necessary adjustments in orbiting and orienting the satellite will be made by command from the ground.

It is this aspect of the system which NASA officials believe is most noteworthy. Almost all attitude control systems in earlier light satellites have been commanded from within the spacecraft, using heavy complex equipment.

The satellite will carry an array of 3960 solar cells to supply power and charge nickel-cadmium batteries which will power the satellite's instrumentation when it is not in the sunlight.

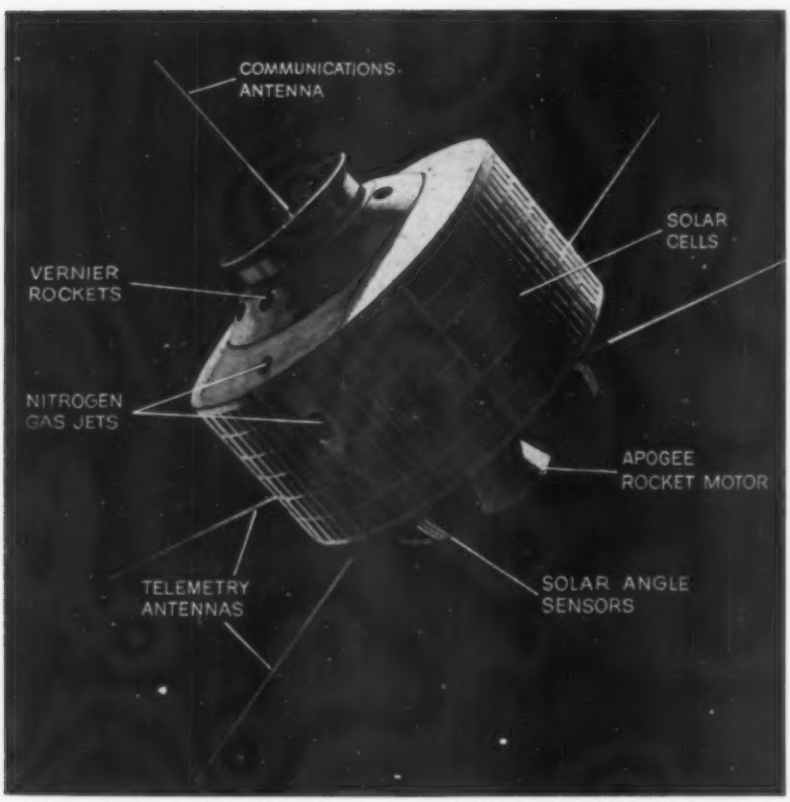
The system is designed to give the *SYNCOM* a "working" lifetime of one year, supplying 20 watts of power at 27.5 volts.

• **Redundancy**—There are duplicate telemetry and communication systems (including command systems).

The satellite will also have two antenna systems. A slotted-array antenna projecting from one end of the spacecraft will receive and transmit the telephone and telegraph communications. Telemetry will be transmitted by means of four whip antennas which are attached at the opposite end of the spacecraft, projecting outward 90 degrees apart in turnstile fashion.

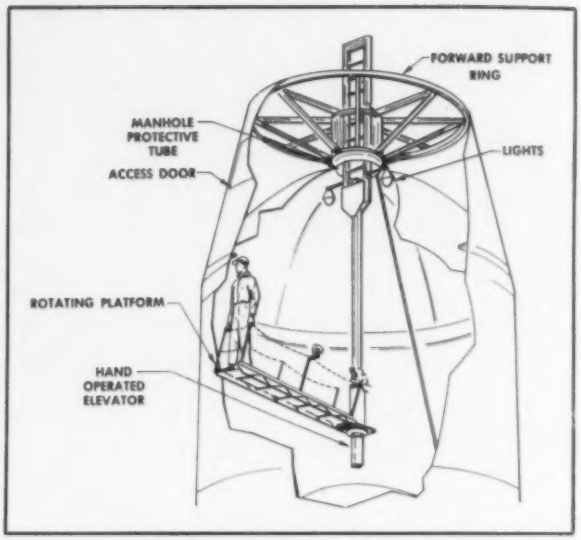
Communications signals will be sent to the satellite on a frequency of 7500 mc. The signal will be amplified by a lightweight traveling wave tube and retransmitted to the ground on 1850 mc. Telemetry will be transmitted on 136 mc. In addition to relaying "real time" data on the attitude of the satellite, information will be telemetered relating to the solar cells, the communication systems, jet reaction system, and spacecraft temperature.

The satellite will be stabilized in orbit by spinning it like a gyroscope. Its spin axis will be perpendicular to the plane of the orbit and generally will be north-south in relation to the earth. Spinning, with the cylindrical part of the spacecraft always facing the earth, the satellite will transmit a circular beam with its edge always toward the earth. ⌗



ARTIST'S CONCEPT of NASA communication satellite to be launched in 1962.

Saturn S-IV Transportation



Interior of Tank Access Kit

support equipment

Saturn S-IV Hints at Future Problems

Too big for long-distance travel by rail or highway, S-IV will travel mainly by water; blimps, aircraft piggy-back have potential

TRANSPORTATION and handling techniques are becoming a major influence in the design of massive U.S. rockets—thrust, mission and other more familiar criteria will soon take a back seat in comparison with the less glamorous tasks of packing and shipping.

For example, the *Saturn S-IV* stage will have transportation and support problems peculiar to itself—even though it is but one section of the complete *Saturn* vehicle.

H. L. Lambert of Douglas Aircraft Co. told members of the Society of Automotive Engineers in Los Angeles last week that the *S-IV* is too large for long-distance railroad or highway movement.

In addition, special transport equipment and packaging is necessary. Checkout and handling apparatus will have to be built especially for the *S-IV*.

• **Piggy-back transit**—Because of its size, the stage cannot be carried in the cargo compartments of any existing aircraft. Its weight precludes the use of current helicopters. Lambert says blimps offer intriguing possibilities for long-range transport, and these will receive consideration in future designs involving larger vehicles.

A piggy-back method using a C-133 aircraft is under study. The stage, with aerodynamic fairings, could be mounted on top of the aircraft, and after some slight modifications in the form of vertical stabilizers, could easily operate off standard runways. This offers coast-to-coast capability.

Present plans call for moving the *S-IV* from the fabrication area at the Douglas Santa Monica plant to a Douglas facility at Sacramento for acceptance firing of the engines.

After completion of this phase, the vehicles will be shipped to the Atlantic Missile Range (AMR) for launching. One vehicle will go to Huntsville for dynamic testing prior to delivery at AMR.

The Sacramento trip will be handled with barges. The *S-IV* remains in its transporter at all times except when actually placed in the launch or test stands. A total time of 3-4 days will be involved in this leg of the move.

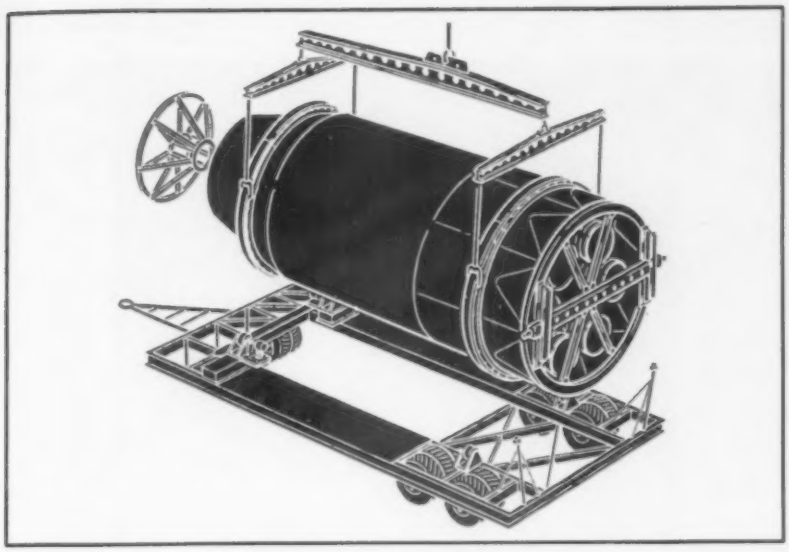
• **Saturn by sea** — Studies have shown that water transportation offers the most readily available solution. In line with this, the *S-IV* will be placed aboard an ocean freighter in San Francisco Bay after the acceptance firings. Then it will be shipped via the Panama Canal to either Huntsville or AMR.

If the destination is Huntsville, the *S-IV* must be shifted to another barge at New Orleans for its 1470-mile, 14-day trip up the Mississippi, Ohio and Tennessee Rivers to the Marshall Space Flight Center.

An estimated 33 days will be required to move the stage from San Francisco to Huntsville, and 17 days to Port Canaveral from the West Coast city.

The transporter itself is a unique vehicle. It is a towable, fifth-wheel-type approximately 46 ft. long, 22 ft. wide and 3 to 5 ft. high. With the stage aboard, it is capable of a speed of about 10 mph. Major structural members are expanded "I" beams. The unit weighs about 15,000 lbs.

The undercarriage consists of six



Transport Handling Kit

s in Transport, Handling

low-pressure, highly flexible, Goodyear Terra Tires eliminating the need for spring suspension. The transporter can be dropped over a foot onto a concrete surface without exceeding the 2g loading restriction on the *S-IV* stage.

During transit, Lambert says, the vehicle will be covered with double-walled inflatable, neoprene-impregnated nylon.

At the Sacramento test facility, ground support equipment includes the fuel tank access kit, a diffuser access kit and the weighing system. The latter is a system designed for accurately weighing the stage before and after fueling. A tension-weigh system is used, and Lambert anticipates an accuracy within the $\pm 0.5\%$ tolerance required.

The tank access unit provides servicing, repair and inspection capabilities. The crane-lowered assembly gives the inspector three degree of freedom. The platform section has a hand-operated winch for height adjustments and the ladder extension is pivotable through a complete circle with certain tilting means to allow access to lower corners of the *S-IV*.

The Douglas *Saturn* stage is one of the first vehicles requiring engine tests in a simulated space atmosphere. These tests call for 31-ft. diffusers for each engine.

The diffuser is essentially a venturi that sustains its vacuum by engine exhaust flow. Using a steam ejector, air is evacuated from each diffuser until the desired altitude simulation is reached.

At the launch site, another ticklish handling problem arises. The light weight of the vehicle and its large projected area will cause the *S-IV* to sway at low wind velocities—if erected by a single hook. Guiding is a must, says Lambert. Studies are now under way to determine the extent of hoisting and mating problems during ground wind conditions.

Lambert says the *S-IV* is truly a baby when compared to future concepts in space vehicle boosters. As these pieces of hardware get larger, many "common" means of handling in use today will be out of the question.

"Transportation looms ominously as a specific problem that must be studied immediately." The point has already been reached where handling and transportation are imposing limitations on concept considerations in design of the vehicles themselves.

The development of large solids will make the problem even more acute. ■

GE Re-entry Bodies Used As 'Poor Man's Space Lab'

THREE MICE were sent into space in a nose cone and recovered alive recently at a total cost of approximately $20,000.

This neat low-budget accomplishment was made possible by the existence of "Space Lab," a little-known and unpublicized service of General Electric's Missile and Space Vehicle Department.

Officials at MSVD like to call it the "poor man's tool" for space research.

Several years ago, these officials realized that they had a lot of space on their Mark 2 re-entry body. They approached the Air Force's Cambridge Research Center with the idea that this space should be utilized by scientists who had experiments that required a space environment, but didn't have the funds to pay for booster and range facilities.

Once the Air Force had given its blessings, MSVD established the Space Lab Program—then known as the "J" program.

The limited space available on the Mark 2 meant that only two and one-half experiments could be flown per vehicle. However, when MSVD began producing the RVX 1 and 2 re-entry vehicles, the number of experiments that could be carried on a given flight took an order-of-magnitude jump to 16-18. With the advent of the Mark 6 program, it will be feasible to increase the number of experiments to 50.

• **How it functions**—Long before an anticipated flight, MSVD sends out information to various scientific and industrial organizations—mostly within the Air Force, although the program is not limited to AF contractors—outlining the dimensions, volume, weight and other details of the re-entry body space available for experiments.

If a firm has an experiment that it wishes to fly, it submits a synopsis of the proposed test to MSVD. When all the requests are received, Space Lab officials compile a list of the experiments in order of priority. This is submitted to the Air Force for approval. Once the list is approved, the experimenter is notified.

• **Ground rules**—Anyone flying an experiment understands that, since the missile flights have other primary missions, their package goes along on strictly a non-interference basis. Once it is installed aboard the re-entry body, it will not be monitored during checkout and only the most rudimentary functions—such as turning on power prior to liftoff—will be accomplished. ■

AWCS-412-L Consisting of a closely coordinated network of data acquisition stations, data processing and display centers and weapon bases, **Air Weapons Control System 412-L** provides the tools for effective and flexible air space management, continent-wide or in single point defense. Vital detection and tracking information is supplied automatically to human decision-makers within seconds. Effective direction of both manned and unmanned weapons, including return of manned aircraft to base, is a system function.

412-L STAFF EXPANDING

as program moves ahead in advanced development phase

If you are one of the fast-growing group of scientists and engineers who recognizes the unequaled career advantages and satisfactions to be gained through work on very large-scale, complex systems, we urge you to scan this abbreviated list of current openings on 412-L. If your background, experience or interests are represented, write us today. We promise you a careful review of your qualifications and a prompt reply.

COMMUNICATION SYSTEMS

Training in information theory and switching theory; broad experience in both RF and wire communication systems design, especially automatic subscriber and dial systems; to determine and specify characteristics for intra- and inter-site command and control complexes.

OPERATIONS ANALYSIS

Involves synthesis/analysis of computer oriented weapons control systems (ground/air environments) from an operational standpoint. Estimates system (personnel & equipment) capabilities; derives and evaluates system procedures using analyses and computer simulation as tools. BS/MS – minimum 3 years experience.

EQUIPMENT EVALUATION

Solving man-machine problems, evaluating alternative components, displays, or techniques, devise simulators. Advanced degree in experimental psychology required.

SYSTEM EQUIPMENT ANALYSIS

Performs analysis on system-equipments and their functions; derives criteria and parameters to meet operational requirements. Work in areas of signal processing, detection, tracking and digital communications. Requires BS/MS/EE/Physics/Math—knowledge of simulation techniques, feedback theory, probability and information coding desirable. 3 years experience.

WEAPONS INTEGRATION

Determines and specifies optimum weapon utilization. Specifies weapon interfaces to equipment designers to insure system compatibility. Support / provide analytical inputs relative to weapons capabilities; analytical studies to assure optimum weapon employment within specific computer capabilities. BS/MS. 2 years manned/unmanned weapons system experience.

INFORMATION PROCESSING & DISPLAY SYSTEMS

Training in information and statistical theory; broad experience in design and integration of tactical and strategic data processing systems; to define system parameters, identify interface problems, perform math analyses of control loops as applied to real-time processing and display systems.

TECHNICAL WRITERS

Creation of systems manuals, engineering reports, proposals; required is at least 2 years of technical education with minimum of 5 years in engineering writing. Knowledge of graphic arts techniques would be helpful.

PROGRAMMING ANALYSIS

Degree required. Math background; 2 years experience on medium/large-scale digital computers solving real-time military operational problems. Activity ranges from problem analysis to program development, including flow diagramming, coding and debugging in the utility control, simulation and operation areas.

ANTENNA & MICROWAVE COMPONENTS

BSEE, advanced degree preferred; experience with high power phenomenon, antenna development, RF plumbing, modulators, transmitters and receivers.

APPLIED MATHEMATICS

Performs mathematical analyses on all phases of ground electronic control systems. Utilizes probability theory, numerical analysis, complex variables; knowledge and utilization of analog/digital computers desirable. BS/MS Math required; 2 years experience on applied math problems in engineering field.

Write in confidence to Mr. P. W. Christos, Div. 73-WP

DEFENSE SYSTEMS DEPARTMENT (A Department of the Defense Electronics Division),
General Electric, Northern Lights Office Building – Syracuse, New York

An Equal Opportunity Employer

GENERAL ELECTRIC

A look at what's ahead in the realities of space exploration

Some predictions from Douglas —the company that has helped launch 70% of all U.S. satellites & space probes

Our mastery of space has advanced so rapidly that only diehard pessimists doubt the moon and planets will know our footsteps within a few decades.

Already a vehicle capable of orbiting a 19,000-pound payload, or driving 5,000 pounds to escape velocity, or lofting 2,500 pounds to Mars or Venus is being built in the U.S. This is Saturn, taller than a 14-story building, with an initial thrust of 1.5 million pounds. Its second stage, under construction for NASA by Douglas, will use a cluster of liquid hydrogen-oxygen engines of unique design.

The world knows a man can rocket into space and return. Can he survive for long periods? Douglas studies give a strong affirmative. Zero gravity and artificial G require further study. Radiation is a continuing problem, but reports from Discoverer XVII, one of 46 space projects launched by the Douglas Thor rocket, show the threat less serious than was first thought.

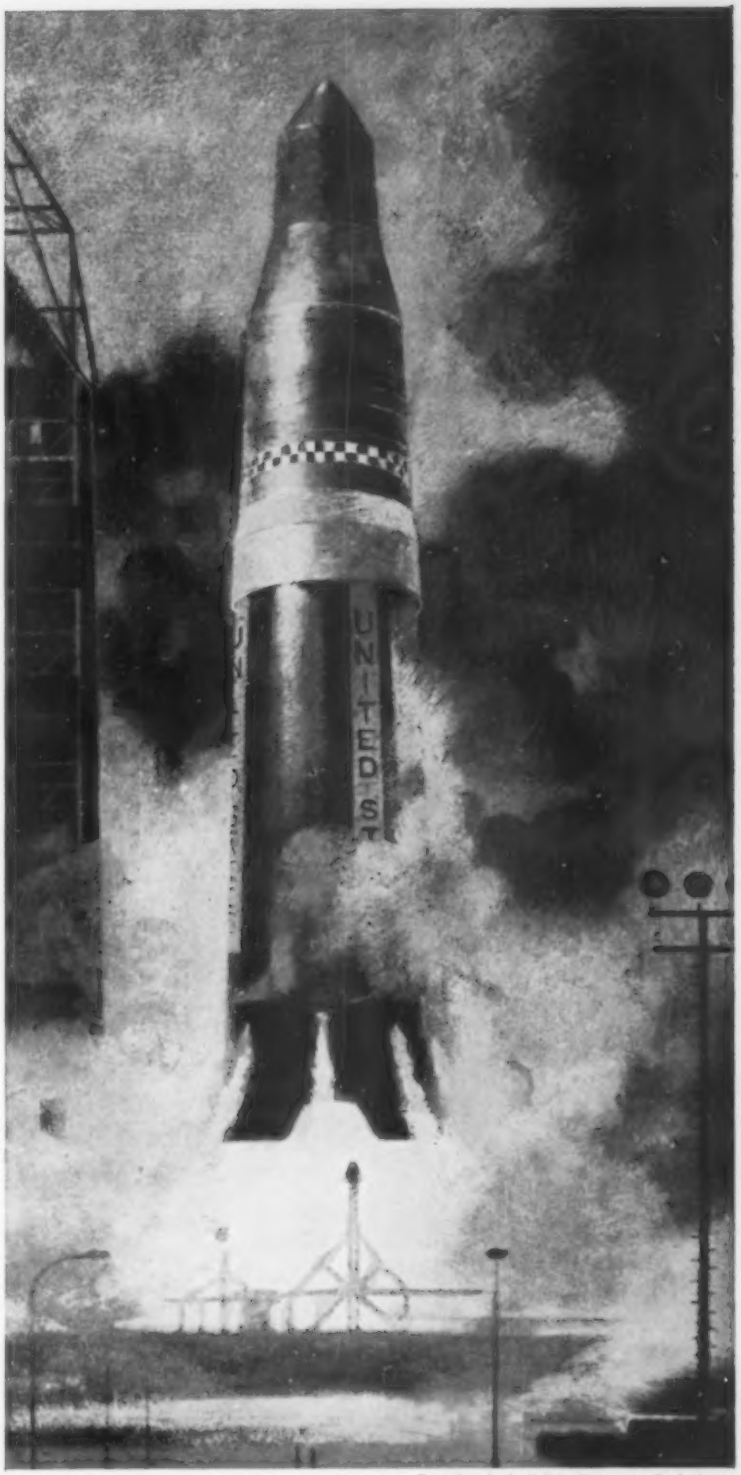
The cost of space travel? A breakthrough in nuclear power, which Douglas engineers confidently predict, should cut the operational cost of a trip to the moon to about $900 per passenger. Other power sources, already under study, may even open such stars as Sirius and Alpha Centauri to travel.

The DC-8 Jetliner, an example of Douglas aero-space leadership

Few of us will ever be lunar commuters, but growing millions are learning about a new kind of travel through the DC-8 jet.

Here is an airplane that slices through time at 10 miles a minute, opens the world to all who have an urge to get up and go places.

Next trip, fly a DC-8 jet, newest of which is the DC-8 Series 50, fastest long-range jetliner in the sky.



Douglas is building Saturn's 2nd stage.

DOUGLAS

DOUGLAS AIRCRAFT CO., SANTA MONICA, CALIFORNIA • MAKERS OF MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • AIRCOMB® • RESEARCH AND DEVELOPMENT PROJECTS • GROUND SUPPORT EQUIPMENT • ASW DEVICES

50 MILLIONTHS

The rotor of Sperry's new Mark 1 Mod. 2 gyro spins on a cushion of hydrogen, with clearances of only 50 millionths of an inch between it and the journal. The gas bearing, replacing the ball bearing of earlier models, reduces both production time and cost—and at the same time provides 300 to 400 percent higher accuracy for the Sperry Mark III SINS (Ship's Inertial Navigation System) designed for Navy's Polaris subs.

This big bonus in accuracy will be of vital importance to the Polaris missile; the entire system accuracy derives from it. And the accuracy must be there not for the few minutes it takes to put a missile on its trajectory, but for the days, weeks and months it is poised for action in the submarine beneath the sea. Actual Navy tests of production units of the Mark 1 Mod. 2 have shown it to surpass today's gyro standards many times over. With slight modifications to present inertial systems, these second generation gyros can replace their predecessors for added navigational accuracies.

SPERRY

MARINE DIVISION, SPERRY GYROSCOPE COMPANY • DIVISION OF SPERRY RAND CORPORATION, SYOSSET, N. Y.

Circle No. 10 on Subscriber Service Card

If you are a hardwar
atmosphere of field
offers you an import
throughout the Unit
range of technical as
operational capabilit
Base Activation Engi
lation, checkout, an
borne equipment. Sp
detailed on the back
These positions pro
satisfaction of workir
advanced, but of vita

GENERA

e a hardware-oriented engineer who enjoys the shirt-sleeve
ere of field assignments, General Dynamics | Astronautics
u an important role in the activation of Atlas ICBM bases
ut the United States. The basic task is providing a wide
technical assistance to the Air Force in bringing bases to
al capability.

ivation Engineers function at the systems level in the instal-
eckout, and acceptance of ground support and missile-
uipment. Specific requirements and locations of work are
on the back of this page.

positions provide stability, growth opportunity, and the
on of working on a program which is not only technically
, but of vital significance to the security of the free world.

For a prompt, confidential reply, use the attached Professional Placement Inquiry card or write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Department 130-90, General Dynamics | Astronautics 5700 Kearny Villa Road, San Diego 12, California. Candidates who live in the New York area may find it more convenient to contact Mr. E. Hart or Mr. T. Cozine General Dynamics | Astronautics, 1 Rockefeller Plaza, New York, telephone, CIrcle 5-5034.

ENERAL DYNAMICS

ASTRONAUTICS GROUP
FORMERLY CONVAIR / ASTRONAUTICS

PROFESSIONAL PLACEMENT INQUIRY

This card may be folded and sealed or stapled and mailed in complete confidence. It will enable the professional staff at General Dynamics | Astronautics to make a preliminary evaluation of your background. A personal interview can be arranged in your city by appointment. Every completed inquiry will be acknowledged.

NAME _____

STREET ADDRESS _____

CITY & STATE _____ TELEPHONE _____

NEAREST MAJOR CITY (IF APPLICABLE) _____

COLLEGE GRADUATE: YES ☐ NO ☐ DEGREE: BS ☐ MS ☐ PhD ☐

YR ____ YR ____ YR ____

MAJOR SUBJECT:

AERONAUTICAL ENGINEERING	☐	MECHANICAL ENGINEERING	☐
ELECTRICAL ENGINEERING	☐	MATHEMATICS	☐
ELECTRONIC ENGINEERING	☐		
CIVIL ENGINEERING	☐	PHYSICS	☐

OTHER _____

FOLD

EXPERIENCE:

PRIMARY SPECIALTY _____ YRS _____

SECONDARY SPECIALTY _____ YRS _____

ADDITIONAL COMMENTS, IF ANY, CONCERNING YOUR JOB INTERESTS:

PLEASE SEND GENERAL DYNAMICS | ASTRONAUTICS RECRUITMENT BROCHURE: MR-10 ☐

AN
IMPORTANT
MESSAGE
TO
ENGINEERS

BUSINESS REPLY MAIL
No Postage Stamp Necessary if Mailed in the United States

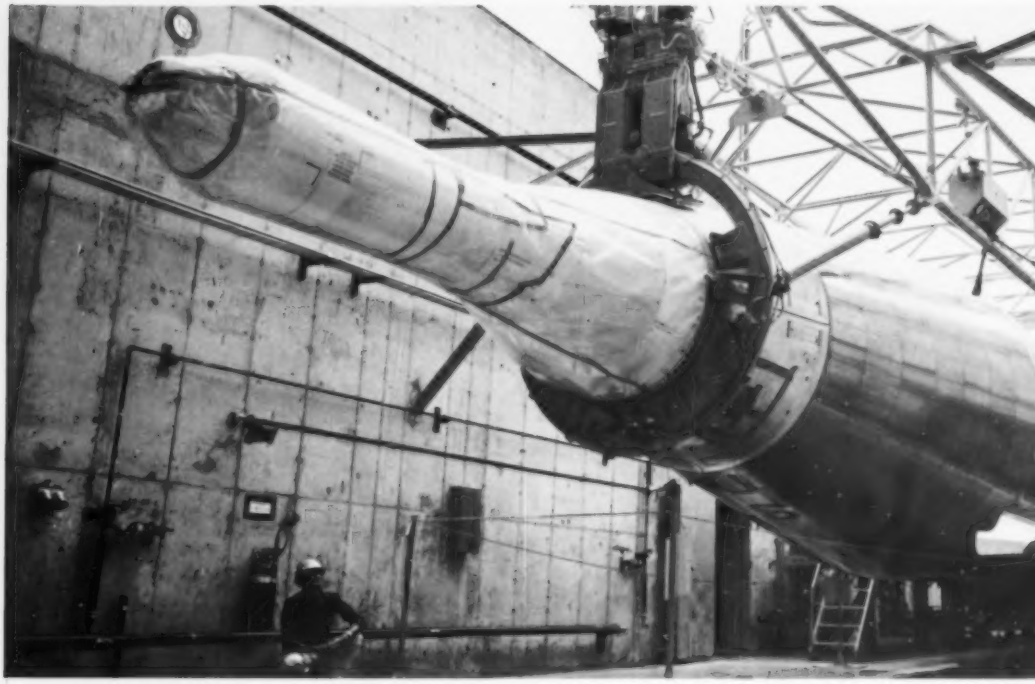
POSTAGE WILL BE PAID BY

GENERAL DYNAMICS | ASTRONAUTICS
POST OFFICE BOX 1128
SAN DIEGO 12, CALIFORNIA

PERSONAL AND CONFIDENTIAL
ATTENTION: MR. R. M. SMITH
MAIL ZONE 130-90

FIRST CLASS
PERMIT NO. 1524
SAN DIEGO, CALIF.

ENGINEERS FOR BASE ACTIV



ATLAS MISSILE shown in horizontal launcher at operational base. Current assignments for base activat
Oklahoma; Abilene, Texas; Roswell, New Mexico; Plattsburgh, New York.

DESIGN/LIAISON ENGINEERS

Tasks involve liaison and design support work in connection with launch control equipment, propulsion systems, automatic programming and missile checkout equipment. A degree in mechanical or electrical engineering and systems experience desired.

ENGINEERING WRITERS

To prepare maintenance, operation, and inspection manuals, and engineering proposals. At least two years of college engineering and from one to three years of experience in this field desired.

FIELD SERVICE ENGINEER

Assignments are for specialists ca
the company to the Air Force in
the Atlas ICBM. An engineering d
ence desired.

ELECTRICAL/ELECTRONIC

Graduate engineers with field e
controls, logic control systems,
equipment, guidance and flight con
power, electronic systems, R.F. s
landlines, or autopilots.

For a prompt reply and a personal interview in your area, complete and mail the attached Professional Placement Inquiry today. If it has been removed, write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, General Dynamics | Astronautics, Dept. 130-90, 5700 Kearny Villa Road, San Diego 12, California.

LIBERAL ALLOWANCES ARE PROVIDED FO
MEN ASSIGNED TO FIELD OPERATIONS

AN EQUAL OPPORTUNITY EMPLOYER.

GENERAL DYNAMICS ASTRONAUTICS
FORMERLY CONVAIR/ASTRONAUTICS

CTIVATION

r base activation engineers are at Altus,

ENGINEERS

pecialists capable of representing Air Force in technical aspects of ngineering degree and field experi-

CTRONIC ENGINEERS

with field experience in launch ol systems, automatic checkout nd flight control, facility electrical ems, R.F. systems, telemetering, .

complete day. If it Relations cs, Dept. ia.

DED FOR ATIONS

UTICS GIIIID
TRONAUTICS

WANT MORE INFORMATION?

USE THIS HANDY FREE READER SERVICE CARD TO GET MORE DETAILED INFORMATION ON ADVERTISEMENTS, NEW PRODUCTS, TRADE LITERATURE FEATURED IN THIS ISSUE.

We can't process the card unless company affiliation and title are given. Use home address for employment ads and please limit your requests to ten items.

NAME

TITLE/POSITION

COMPANY

Product Mfg./Service Offered

BUSINESS ADDRESS

CITY ZONE STATE

MISSILES AND ROCKETS

OCTOBER 16, 1961

Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

• • Other Information

GET ALL THE DETAILS . . .

ABOUT ADVERTISEMENTS AND NEW PRODUCTS IN THIS ISSUE.

1. **Circle the appropriate reader service numbers on the reverse side of the card below.**
2. **Fill out the card completely . . . company affiliation and title are a MUST.**
3. **Tear out the card and drop it in the mail box—we pay the postage and we contact the manufacturer for you.**

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY MAIL

First Class Permit No. 47, Ridgefield, Connecticut

Postage Will be Paid by Addressee

MISSILES and ROCKETS

P. O. BOX 621

RIDGEFIELD, CONNECTICUT

SUBSCRIBER SERVICE DEPT.

Shepard on Apollo:

Manned Control Called Essential to Success

LOS ANGELES — Astronaut Alan B. Shepard, Jr., predicts that manually operated systems will be the rule in the *Apollo* program, including all stages of the booster.

"It is my feeling," Shepard told the Society of Experimental Test Pilots, "that man can provide the input to actually fly the spacecraft into orbit, control the velocity vectors into a translunar trajectory, perform midcourse corrections, execute the moon landing and take-off and provide the necessary control during re-entry and landing on the earth."

Man, he indicated, will be used in the *Apollo* program in the same way Project *Mercury* utilized parallel systems to insure reliability.

"For example, many of the final stages or segments of thrust vectors could be saftied prior to leaving the earth. The crew could get outside, go back to the appropriate stage once the flight was in space, and arm or prep or perhaps repair the particular power stage required. If one is to walk around the moon, collect samples, and prepare for take-off, why not do the same timely functions on the way out or the way home?" America's first astronaut said.

• **Leeway for landing**—In addition, he said that man appears to have a definite place in the operation of the spacecraft.

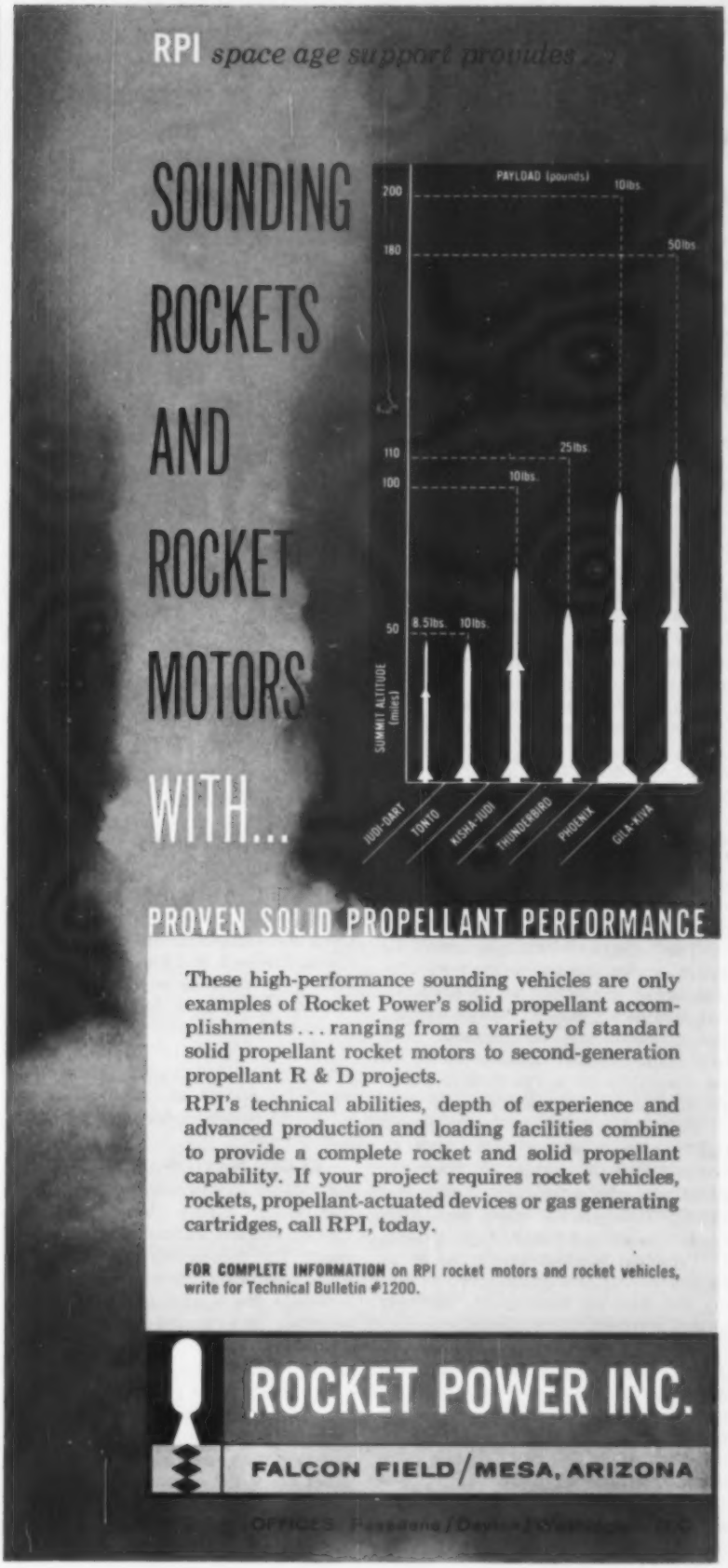
Besides operating as a team during critical periods of flight such as takeoffs and landings, the crew will also function on a watch-sharing basis during long periods of translunar or transearth flight.

Final external configuration for *Apollo* has not been decided, Shepard said, adding that it is valid to assume that a lifting vehicle will allow for adjustment of trajectories on return at escape velocities.

Shepard said that in-flight repair or exchange of modular-type equipment may very well assure the success of the mission.

"Last, and perhaps most important," he declared, "it does not appear realistic to assume that a moon landing can be made using automatic systems and a command system functioning solely from an earth base."

"Exploratory probes can perhaps be made and lunar orbit data can be obtained using automatic unmanned systems. But landing and return, within the time period allotted, is not within the state of the art unless we provide the man for reliability," he concluded. ⌗


RPI space age support provides
SOUNDING ROCKETS AND ROCKET MOTORS WITH...
PAYLOAD (pounds)
200
180
110
100
50
10lbs.
50lbs.
25lbs.
10lbs.
8.5lbs.
10lbs.
SUMMIT ALTITUDE (miles)
JUDI-DART
TONTO
KISHA-JUDI
THUNDERBIRD
PHOENIX
GILA-KIVA
PROVEN SOLID PROPELLANT PERFORMANCE
These high-performance sounding vehicles are only examples of Rocket Power's solid propellant accomplishments . . . ranging from a variety of standard solid propellant rocket motors to second-generation propellant R & D projects.
RPI's technical abilities, depth of experience and advanced production and loading facilities combine to provide a complete rocket and solid propellant capability. If your project requires rocket vehicles, rockets, propellant-actuated devices or gas generating cartridges, call RPI, today.
FOR COMPLETE INFORMATION on RPI rocket motors and rocket vehicles, write for Technical Bulletin #1200.
ROCKET POWER INC.
FALCON FIELD/MESA, ARIZONA

Circle No. 19 on Subscriber Service Card

Atlantic Research Doubles Work Space at Home Plant

ATLANTIC RESEARCH Corp. has dedicated a $1.6-million building which doubles working space at its headquarters and principal laboratories in Fairfax County, Va.

The 123,000-sq.-ft. addition houses two ARC divisions—Jansky & Bailey and Desomatic Products—which were formerly located elsewhere in the Washington, D.C., area, as well as the company's Electromechanical Division.

Vice Adm. William F. Raborn, chief of the Navy's *Polaris* program, was main speaker at the dedication ceremonies. He singled out ARC's work in improving the specific impulse of solid propellants as the "key" to making *Polaris* feasible.

Rear Adm. D. M. Morrison, Chief of Operations, U.S. Coast Guard, delivered a special commendation to the Jansky & Bailey Div. for outstanding services in the field of maritime communications and navigation.

Atlantic Research has diversified its interests, acquiring seven firms in related areas since 1959, but its chief work continues to be in solid-propellant rocket research and manufacturing.

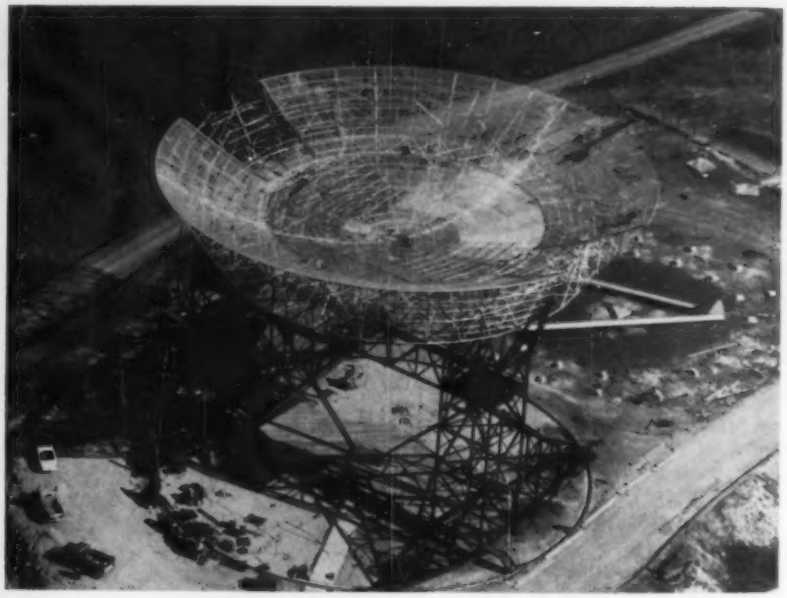
ARC has been researching for some time its gel-solid concept of propulsion for big space boosters. It has also been studying slurry fuels for several years, and recently received a $250,000 Air Force contract to support this effort.

The company manufactures the *Arcas, Archer* and *Iris* research rockets, is in initial production of an advanced sustainer rocket for the Navy's *Terrier*, and is completing development of a combination booster-sustainer motor for the Army-Marine Corps *Redeye* shoulder-fired antiaircraft missile.

Founded in 1949, the firm's original staff was composed of Dr. Arch C. Scurlock and Dr. Arthur W. Sloan, the co-founders. Its initial capitalization was $1000. Today it has more than 1800 employees and net worth of $9,507,845.

President Scurlock announced at the dedication that new orders received during the first six months of this year totaled a record $11.7 million.

As reported earlier (M/R, Sept. 4, p. 45), ARC sales during the first half were $9,039,071—up 51% from the same period in 1960. Net earnings were $606,036 or 34 cents a share, compared with $329,482 or 21 cents a share in the first half last year. ¤



Big 'Dish' Erected at Stanford

THE STANFORD DISH, a $350,000 research instrument designed and built by Stanford Research Institute scientists supported by the Air Force Office of Aerospace Research, is a 70-ton, 150-ft. steel and aluminum parabolic antenna.

THE MARTIN CO. and American-Marietta will consolidate into the Martin-Marietta Corp. George M. Bunker, Martin chairman, will be president and chief executive officer and Grover M. Hermann, A-M chairman and founder, will be chairman of the new board of directors.

PRATT AND WHITNEY AIRCRAFT, division of United Aircraft Corp. has established an Advanced Materials Research and Development Laboratory to produce new materials for aircraft, space and industrial powerplants of the future.

Principal goals of the Lab will be development of high-strength materials, alloys for service at extreme temperatures and materials for energy conversion devices.

ELGIN NATIONAL WATCH CO. will double its Micronics plant production space. Elgin's president, R. O. Fickes, said the additional space is necessary for production of missile and space equipment. "We expect to participate to a much greater degree," Fickes asserted, "in advanced systems and programs as they are called for by the defense program and private industry."

GARRETT CORP'S AiResearch Manufacturing Div. of Los Angeles is expanding its product line into storage, transportation and pumping of cryogenic fluids for ground support.

The expansion will include new products, a new facility and addition of engineering and fabrication personnel. No details on a site for the new facility were announced.

NATIONAL CARBON CO., Division of Union Carbide Corp., says it is planning a $500,000 expansion of its Lawrenceburg, Tenn., facilities for the production of high-density graphite for the nation's space program.

THE BOEING CO. has consolidated its advanced marine work into one group, the Advanced Marine Systems Organization.

Work includes a $2-million hydrofoil subchaser under construction for the Navy. The test program will include use of the division's hydroplane, recently completed to test foils and other marine shapes.

The new organization will also be responsible for a broad effort in ASW and other marine programs now under way.

PROPELLANT TECHNOLOGY, Palmdale, Calif., has been formed to process composite solid propellants and produce solid-propellant manufacturing and testing equipment.

Operations have been scaled to provide services to the small batch user of custom solid propellants. Testing facilities will accommodate rocket motors up to 15,000 lbs. thrust.

Reaction Devices, the equipment manufacturing division, produces fully automatic laboratory solid-propellant

Left—The scene: UTC Development Center. The action: static firing test is monitored on closed-circuit TV in Remote Control and Data Acquisition Center.

INTERVIEWS NOW ARE BEING CONDUCTED FOR THESE POSITIONS

Sr. Design Engineer—Supervision of a group in design of solid rocket motor components. Requires professional degree and a minimum of 5 years rocket design experience.

Engineering Analyst—Systems Design. To formulate mathematical models of systems engineering problems and implement solutions by analytical techniques. Requires degree with solid mathematical foundation and 2 years design or systems experience.

Organic Chemist—Propellant development research involving synthesis of basic monomers, plasticizers and organic compounds. Requires an advanced degree in organic chemistry with a knowledge of advanced organic synthesis. Experience in synthesis of reactive compounds is most desirable.

Capability backed by four decades of propulsion experience

UNITED TECHNOLOGY CORPORATION

P. O. Box 358, Sunnyvale, California

A subsidiary of United Aircraft Corporation

Is there a future for you with UTC?

Are you an engineer or scientist with a record of achievement?

Would you enjoy applying your talents to major programs in advanced propulsion—large segmented solid propellant rocket engines, hybrid rocket engines and storable high energy liquid propellant engines?

Would you find it stimulating to work directly with recognized professional leaders at a modern multi-million-dollar complex, where you could avail yourself of the very latest techniques, methods, ideas and equipment?

Would you appreciate living in the San Francisco Bay area, which features "West Coast living" at its finest? Plus the possibility of financial gain if you can give evidence of real creativity and initiative? This is what the future holds at UTC. If you are interested, we invite you to contact C. F. Gieseler, Dept. 104, United Technology Corporation, Box 358, Sunnyvale, California. All replies treated in strictest confidence.

Research Processing Chemist—For laboratory investigations of polymeric materials that may be used as liners, and adhesive or encapsulating agents, and allied research. Strong background in organic chemistry and synthesis including a degree in chemistry or chemical engineering is necessary.

Aerothemo Specialist—Will perform heat transfer thermodynamic and aerodynamic studies on rocket motors, develop new methods of analysis and design tests. Will consult with designers and project engineers on major engine programs. Requires masters degree in mechanical or aeronautical engineering and 4 years experience in thermodynamics and heat transfer.

Process Engineer—For rocket motor processing studies and process methods improvements. Requires chemical engineering degree and direct propellant processing experience.

Propulsion Engineer—For analytical studies of solid and liquid propulsion systems. Requires degree with extensive mathematics, thermodynamics and fluid mechanics background.

Positions also for process operations supervisors.

All qualified applicants considered without regard to race, creed, color or national origin.

recognize the family?

You might. They keep the best of company. And they're just part of the *total* data recording capability only CEC can give you. □ There are Magnetic Tape Recorders for ground station systems and portable use . . . Tape Degaussers . . . D-C Amplifiers . . . Multichannel Recording Oscillographs with a complete line of recording papers and processing chemicals . . . Transducers, too. A whole lot. From data input to output, the CEC family is the most extensive and compatible anywhere! □ Special project? CEC can handle it. As they did with the Mercury Space Capsule Recorder shown in the left middleground. For *any* data recording job, call your nearest CEC office. Or write today for CEC Bulletins 1309-X3 and 1310-X3.

CEC

Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

PASADENA, CALIFORNIA • A SUBSIDIARY OF BELL & HOWELL

Circle No. 20 on Subscriber Service Card

mixers, controlled flow-rate strand burning apparatus, propellant shock testing equipment, small rocket motors, sounding rockets and custom engineered propellant apparatus.

KEARFOTT DIV., General Precision, Inc., has begun work on an addition to its Gyrodynamics building in West Paterson, N.J., as part of a 100,000-sq.-ft. expansion program.

A new research center will assist Kearfott's product-line divisions in development of advanced equipment for control of missiles and spacecraft.

MONSANTO RESEARCH CORP. will begin production and marketing of radioactive sources at its Dayton Lab this fall.

Construction of a radioactive facility and installation of equipment for the production of the nuclear sources is now in progress, and application has been made to the AEC for necessary operating licenses.

WESTINGHOUSE ELECTRIC CORP. has formed a new space materials department to coordinate company activities in development and application of structural materials that will withstand environmental conditions of space, re-entry and hypersonic flight.

The department will be located in the Westinghouse research labs at Pittsburgh, and will focus attention on materials for such structural components as rocket nozzles, vector control mechanisms and nose cones.

ELECTRONIC MEMORIES, INC., Los Angeles, has been formed to develop, design and manufacture ferrite memory cores and core memory systems. Cores for space and adverse environment applications are being developed as well as memories having low power requirements and high reliability for space systems.

GENERAL DYNAMICS/ASTRONAUTICS has put into operation an underwater explosive part-forming facility designed to form special parts for spacecraft.

Explosions take place in a 12-ft. tank, part of the new $40,000 facility comprising two buildings, a five-ton hoist and two explosive magazines.

SPARTAN SOUTHWEST, INC., a subsidiary of Spartan Corp., has dedicated its military electronic facility at Albuquerque, N.M. The 32,000-sq.-ft. building contains general offices; engineering, drafting and laboratory facilities; white room; environmental test lab and plating room.

RAYTHEON CO.'s Semiconductor Division will establish headquarters in Lowell, Mass. The move will consolidate five separate activities in the Boston area. The company estimates that some production will be under way by early November.

WESTINGHOUSE has more than doubled its Sunnyvale, Calif., *Polaris* launcher manufacturing facilities.

The expansion, completed in 15 weeks, brings to 1,304,000 sq. ft. the total working floorspace at Sunnyvale, and augments *Polaris* launcher research, development and manufacturing.

Concurrent with obtaining added space, Westinghouse ordered 25 new light machine tools to turn out *Polaris* parts. Ten machines have been installed and 15 more—five of them automatic tape-control types—will be added by the end of this year.

SPECTRAN ELECTRONICS CORP. has been formed in Maynard, Mass., to develop and manufacture magnetostriction components and instruments. Products will include multiple-filter spectrum analyzers for sonic and electromagnetic waveform studies, and magnetostriction rod filters for frequency reference, analysis and signal selection. The firm will also offer research and product-development services.

VITRO ENGINEERING CO. will build the first nuclear rocket engine maintenance and disassembly building in the nation. The facility will be the first component of the National Nuclear Rocket Development Center, which is expected to be built at the AEC's Jackass Flats, Nev., test site. Engineering work is being financed by NASA.

First Saturn Launch

(Continued from page 17)

This week's shot will be the first of 10 developmental shots which are expected to lead to an operational *C-1* booster in 1964. The *Saturn's* prime mission is to put a three man *Apollo* spacecraft into orbit around the earth.

NASA officials said that while they are optimistic about the chances for success in this week's flight, it is reasonable to expect only about five successful launches out of the 10 scheduled.

The first *Saturn SA-1* vehicle is 162 ft. high. At liftoff it will weigh about 925,000 lbs. For early flights, the eight H-1 engines in the first stage are rated at 165,000 lbs. of thrust each, giving a stage thrust of 1.3 million lbs. Beginning with flight number 5, the engines will have a thrust of 188,000 lbs. each or a stage thrust of 1.5 million lbs.

In the first flight, the booster will carry some 600,000 lbs. of propellant, about 150,000 lbs. less than the rated capacity.

The inert *S-IV* second stage, weighing about 25,000 lbs. will be ballasted with 90,000 lbs. of water. The inert *S-V* third stage has a stage weight of nearly 3000 lbs. and will be ballasted with 100,000 lbs. of water. ⌗

meet the latest member

For a new product, CEC's GR-2800 Recorder/Reproducer is grown-up indeed. It is more versatile, has a higher stability and costs less than any comparable instrument. Proof is in its features: solid state electronics; direct, FM and PDM modes; plug-in amplifiers interchangeable with PR-3300 electronics; magnetic amplifier tape tension control; six standard speeds 1⅞ to 60 ips; direct record response 100 cps – 100 kc; FM response 0 - 10 kc; and 14-channel recorder/reproducer in a single cabinet. □ Want to know more? Call your CEC office or write for Bulletin CEC 2800-X6.

CEC

Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

PASADENA, CALIFORNIA • A SUBSIDIARY OF BELL & HOWELL

Circle No. 21 on Subscriber Service Card

Asides at the ARS Meeting

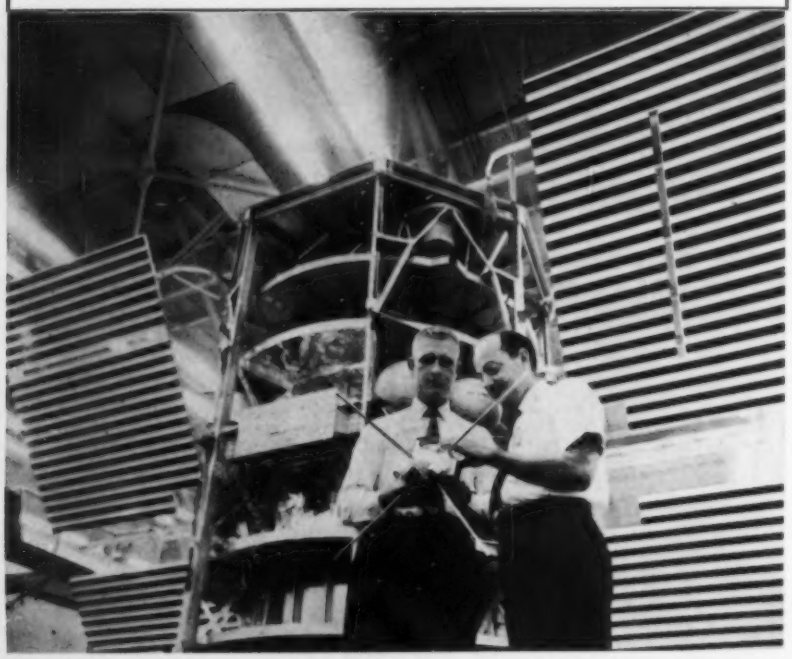
• First experimental Bell System active communications satellite is scheduled for launch by NASA next April. The second is to be launched six months later. Bell displayed a full-scale model of the satellite as a Coliseum exhibit. The company now is testing a developmental model of the satellite in an anechoic chamber at its Holmdel, N.J., laboratories. Bell plans to produce six of the 34-in.-diameter, 150-lb. spheres — one for each launch plus its backup and one spare. Powered by 72 solar-cell arrays, the satellites will be used for experiments in relaying telephone calls, TV signals and for data transmission.

• Increased production—dubbed the "Berlin add-on"—at the Naval propellant plant in Indian Head, Md., is one result of the Berlin crisis. New schedules call for telescoping two years' production into one year, with corresponding increases in the manufacture of five missiles—*Sparrow, Sidewinder, Zuni, Terrier* and *Tartar*. The plant also is being held in readiness for a further production buildup.

• The White House, Atomic Energy Commission and the Department of Defense are taking another look at *Vela Hotel*, the detection system for nuclear explosions in space. No flaws have been found in the planned *Vela Hotel* satellite system but the Administration wants to make sure the system still is the best means of doing the job. As a consequence, no contract has been awarded for the structure, control system or telemetry equipment for *Vela Hotel*, despite design freeze of the detecting and logic portions of the payload at Los Alamos Scientific Laboratory and the Sandia Corp. Contract award now may be delayed until the dust settles in the present international situation.

• Friction between exhibitors and local unions marred early preparations for the big ARS display. Almost every exhibitor had troubles and some were annoyed to the point of seriously considering a boycott on any future dealings with the Coliseum. Industry participants had high praise, however, for the way the entire meeting was handled by ARS.

• Yugoslavia will initiate a sounding rocket program early this spring with the launch of the first of five *Kappa-VI* rockets bought from Japan. Vladislav Matovic, secretary of the Yugoslavia Astronautic Society, told M/R that his society subsequently will build *Kappa-VI's* under license and eventually will be designing and building sounding rockets of its own to explore the upper atmosphere.



CONTRAST at ARS meeting was supplied by full-scale model of Orbiting Astronomical Observatory and Vanguard I, here held by project engineers of Grumman, OAO prime.

Biggest ARS Meeting

(Continued from page 16)

Tests have shown, according to Allingham, that the apparent thermal conductance of this system at chamber altitudes of 200,000 feet is approximately 10% less than with non-ventilated insulation.

• **Vehicle recovery criteria** — As much as 20% of program costs could be saved if space vehicle boosters could be recovered, two Marshall Space Flight Center engineers pointed out.

Reporting on a study being conducted at Marshall, William Porter and R. G. Voss said that recovery is clearly attractive if the combined cost of the recovery operation and refurbishment is less than 55% of the cost of a new booster.

On the basis of immersion tests conducted on a H-1 engine, they discounted the effects of salt water on rocket engines. They proposed that a program using parachute recovery of boosters be initiated.

This recommendation is based not only on the salt-water tests but also on the inability of the Rogallo wing to return to Cape Canaveral without supplemental power or a tow aircraft.

• **Transportation of boosters**—After investigating air, water and overland transport of very large boosters, Martin Co. engineers have concluded that air transport would be the most economical means of booster transport.

The primary advantages cited by Beal M. Teague and John R. Youngquist are flexible scheduling, free from delays such as occurred with *Saturn* at Wheeler Lock, and rapid transport of the booster.

For boosters up to 30 ft. in diameter with gross weights of 100,000 lbs., a glider towed by a C-133B aircraft would be practical. However, for larger boosters, a new tow aircraft at a development cost of $13 million—would be required.

• **Cryotron production shown**—The production techniques and equipment used to manufacture the cryotron—a thin-film, micro-miniature memory unit —were displayed by IBM for the first time.

The device is manufactured in a bell-shaped vessel by deposition of the cryotron material on a plate. The temperature within the bell is maintained at −459°F during the six-hour production time. The cryotron is expected to enable computer engineers to increase the memory capacity and speed of computers and at the same time radically reduce their size. ⊠

NEC meeting hears . . .

New 3-D Systems May Revamp Tracking

by Charles D. LaFond

CHICAGO—Two radically new three-dimensional display systems are being developed to present a target trace with true 3-D continuous images in real time.

Under study for the past 2½ years by the Applied Research Laboratories of Chrysler Missile Division in Detroit, the systems may have far-reaching effects on future displays for space exploration and rendezvous, ASW, missile trajectory determination, and other tracking applications.

The first employs a transparent tank of colorless gel in which an ink trace is deposited by a moving stylus. Semi-solid, the gel offers essentially no impedance to the stylus, yet it is firm enough to suspend the trace. Theoretically, the display tank can be of almost any size, developers say.

The second approach is electronic, using the concept of light impingement on a rotating screen. Screen speed about a vertical axis is high enough—15 rps—to render it invisible to the human observer. The total area swept by the screen describes the 3-D display volume.

By projecting different light beams into the display volume, lines and surfaces are generated. With proper synchronization—and by employing a combination of axial beam entry, curved and sloping screens, simultaneous forward and reverse readout from a memory unit, and other techniques—almost all of the display volume can be used.

The electronic approach is much faster than that achieved with the gel, but both represent truly 3-D display techniques and thus could be an ideal complement to radar tracking or control stations. Real-time presentation would be accomplished using inputs from a computer.

Details of Chrysler's research effort were presented last week at the 17th Annual National Electronics Conference and Exhibition in a paper by C. K. Auvil and C. W. Gattas.

• **NEC details**—Meeting for the first time in Chicago's International Amphitheatre, well over the expected 12,000 electronics scientists, engineers and university students assembled from across the nation to exchange their knowledge. More than 80 technical papers were presented at 20 sessions during the three-day conference.

Although the technical sessions ranged from antennas and bionics to solid-state physics and space communications, the exhibits were notable for lack of interesting systems. The small component was dominant here, and after viewing over 450 stalls showing everything conceivable in electronic hardware, many attendees sorely felt the absence of military and space displays which tend to break the monotony.

The three principal speakers at the conference luncheons were Dr. Lloyd V. Berkner, Institute of Radio Engineers president; Army Brig. Gen. David P. Gibbs, North American Air Defense Command deputy chief; and Robert W. Galvin, president of Motorola, Inc.

Gen. Gibbs, who directs NORAD's communications and electronics systems, reviewed the capabilities of that command and stressed the almost complete dependence of NORAD on C&E operations.

Indicative of the constant modernization of the vast AF electronics complex, he said, is the recently established SPADATS—Space Data and Tracking System—which acquired and tracked Soviet Maj. Gherman Titov's capsule during its orbital passes last summer.

The soon-to-be-operational *Midas* infrared detection satellite system is a similar advance, he asserted. Not only will it complement BMEWS, the Ballistic Missile Early Warning System, but it will provide much-needed early warning coverage of U.S. southern approaches.

Finally, Gen. Gibbs stressed the current need for an effective and reliable anti-*ICBM*. *Nike-Zeus* may eventually do the job, but it still needs "orders of magnitude increase in improvement," especially in its abilities for target acquisition and discrimination. An ICBM priority is needed, he urged, but not to the detriment of our proven air-breathing weapon systems.

• **3-D display concepts**—True three-dimensional displays are needed, said Auvil and Gattas in their paper, to help solve an inherent weakness in operators—the incompatibility in the human mind of high precision and high speed. The use of realistic 3-axis display would improve operator efficiency by offering him the opportunity to evaluate more rapidly a potentially imminent undesirable or dangerous situation.

To react with alacrity, the engineers asserted, displays are needed that will permit man to sense rather than analyze both the nature and magnitude of a problem.

• **Gel-type system slow**—Speed of the gel-type system—1 inch per second—is considerably slower than that of its electronic counterpart. The display, however, is updated continuously and also shows the desired portion of past history. For missile trajectory, an entire flight path could be shown as it progressed.

The gel display was developed first.

Grids, charts, maps, or even solid models can be placed in and around the transparent tank for reference purposes. Light plastic models can be suspended indefinitely in the gel without support.

For a more vivid display, fluorescent inks in a variety of colors may be used.

Accuracy of a displayed trace, developers said, is limited only by stylus deflection, and slightly by the passing of a stylus through a previous trace. Lab models currently are operating at 1 ips and provide accuracies on the order of 3% of error.

Gel life so far appears indefinite.

The stylus is driven in each axis by a positional servo-loop. The present system is designed to follow Cartesian coordinates with input voltages of from 0 to ±100 volts. It can be offset by 100% and may be driven directly from an analog computer.

Input to the display is provided by three chart-scanning function generators. These are synchronized to seam simultaneously all three channels for the 3-D display.

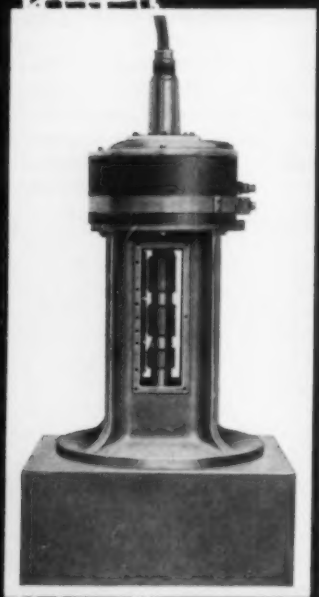
• **Rotating screen system** — Synchronization of the rotating screen and controlled generation of a light spot or line projected into the area swept by the screen will provide a dynamic 3-D display, according to the authors.

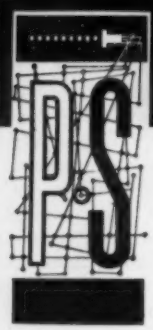
A spot projection generates a pencil beam, a line generates a ribbon beam in space. Interception of either light beam in the screen plane of rotation generates either a line or sheet of light in three dimensions. As the light source moves, so does the area of screen impingement. ⌗

A Poly-Scientific First!

IN VERSATILITY

Poly-Scientific designs and manufactures, by a wide variety of proven processes, top quality slip ring and brush assembly packages for ground support, control and warning systems.





POLY-SCIENTIFIC
CORPORATION
Blacksburg, Virginia
Product Reliability Is Priceless

names in the news

PICCARD

PERENIC

Dr. Claus Haake: Appointed research manager, Giannini Controls Corp.'s Research Laboratories, Pasadena, Calif. Prior to joining GCC, Dr. Haake served as senior physicist for Westinghouse Electric Corp.

Robert W. Mytton and **Charles G. Slemmons:** Appointed operations manager and sales manager, respectively, Kollstan Semiconductor Elements, a division of Kollsman Instrument Corp., Westbury, N.Y.

Dimitri Rebikoff and **Jacques Piccard:** Appointed director of operations and consultant, respectively, for Loral Electronics Corp.'s new oceanography activities. Rebikoff is an internationally known underwater expert, photographer and inventor; Piccard is a consultant on oceanography for the U.S. Navy and recently co-authored a book entitled "Seven Miles Down—The Story of the Bathyscaph Trieste." He also is the son of **Auguste Piccard,** inventor of the "bathyscaph."

Lawrence J. Perenic: Joins S-F-D Laboratories, Union, N.J., subsidiary of Varian Associates, as senior project engineer, subsystems. Prior to joining S-F-D, Perenic was with ACF Electronics Div., ACF Industries, Inc.

Dr. Charles M. Herzfeld: Appointed assistant director for ballistic missile defense research in Defense Department's Advanced Research Projects Agency (ARPA). Recently named associate director of National Bureau of Standards, Herzfeld has been given a year's leave of absence by the Bureau to serve with ARPA, where he will be responsible for coordination of the *Defender* program. **Albert M. Rubenstein** leaves his present position as assistant director for ballistic missile defense to become assistant director for ballistic missile defense engineering.

Anthony M. Barbella: Staff engineer, Instruments for Industry, Inc., Hicksville, N.Y., promoted to chief systems engineer.

Frank J. Shanaberg: Former manager of sales, Industrial Products Div., appointed vice president-marketing, The American Welding and Manufacturing Co., Warren, Ohio. **John P. Lynn:** Appointed general manager of the company's Industrial Products Div. Lynn formerly was manager of manufacturing.

Circle No. 22 on Subscriber Service Card

BARBELLA

SEE

Kenneth D. Greenhalgh: Named manager, Undersea Acoustics Systems Engineering; **L. H. Lynn,** manager-Ordnance Radar Systems Engineering; and **Earl A. Stebbins,** manager-Marine and Ground Radar Systems Engineering; all in General Electric Co.'s Heavy Military Electronics Dept., Syracuse, N.Y.

M. G. O'Neil: President, General Tire and Rubber Co., elected to board of directors, Space-General Corp., Glendale, Calif., a subsidiary of Aerojet-General Corp.

Dr. Elizabeth B. See: Formerly with the El Segundo Div., Douglas Aircraft Co., joins Acoustica Associates, Inc., Los Angeles, as a senior scientist in the Research Dept.

E. V. Huggins: Chairman of Executive Committee and vice president, Westinghouse Electric Corp., elected to second term as president of National Security Industrial Association, Washington, D.C. **Gerald J. Lynch,** vice president of Ford Motor Co.'s Defense Products Group, and general manager of Ford Aeronutronic Div., elected chairman of the board; and **Fordyce E. Tuttle,** scientific advisor to management, A & O Div., Eastman Kodak Co., named vice chairman of the board. **Thomas Meloy,** chairman of the board, Melpar, Inc., named first vice president; **Wencel A. Neumann, Jr.,** president, The DeLaval Separator Co., re-elected chairman of the Executive Committee; and **C. Raymond Smith,** vice president in charge of Defense Activities Div., Western Electric Co., became vice chairman of the Executive Committee.

Harry J. Bolwell: Elected vice president, Midland-Ross Corp., and general manager of the company's Surface Combustion Div., Cleveland, Ohio. Bolwell succeeds **Eugene P. Heiles,** who will retire early next year. In the interim, Heiles will continue as a vice president of Midland-Ross and serve in an advisory capacity to the Surface Combustion and other divisions.

Col. William A. Bennett, Jr. (USAF-ret.): Named administrator, Program Coordination, at Radio Corporation of America's Data Systems Division, Van Nuys, Calif. Bennett's last post of duty was Hanscom Field, Mass., where he was staff advisor in the Electronic Systems Center.

NOW...FROM WINSLOW

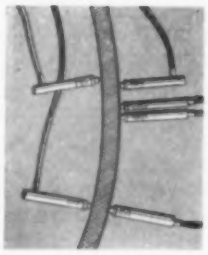
New electronic gaging systems

CUTS READING ERRORS

NO RECORDING ERRORS

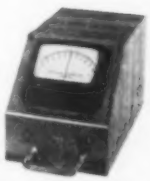
NO VISIBILITY PROBLEMS

CUTS ACCESS PROBLEMS



Uses Winslow Electronic Gaging Probes—sensitive transducers that substitute for standard dial indicators and most air probes in any mechanical "design" gage. Small size of the Probes (3/8" dia. x 2-13/32") allows locating check points where never possible before. Probes can be completely hidden. Console CS-24 (above) shows gage position and variation in lighted numerals 1" high, also prints this information on tape, card or sticker if desired. Push proper button to check any individual point, or machine automatically reads up to 24 gage positions and prints the results. Also reads "thickness" variation between any two opposed Probes. Accuracy possible to nearest .0001". Versatile—use with any number of "design" gages. Write for literature.

ALTERNATE READOUT DEVICES



Model IN-27 reads out a single Probe on meter scale. Can operate automatic sorting devices, etc. Can be ganged to read multiple points simultaneously.

Model LP-9 Electro-Chek* reads each of 9 Probes on the meter as you touch the button. Lighted digital lamp identifies gage position. Optional limit pointers.

Model LP-18 Electro-Chek* reads up to 18 contour points. Also reads "thickness" variation between any two opposed Probes. Compact. Versatile.

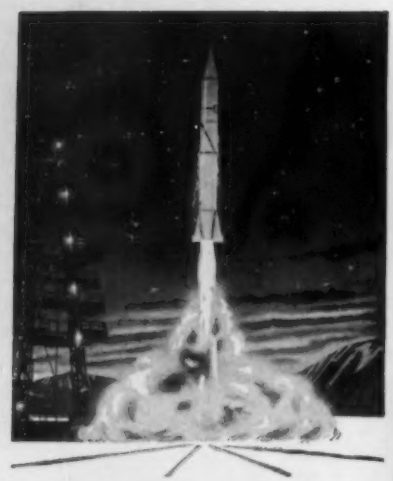
*T.M. Winslow Mfg. Co.

ACCURACY THROUGH ELECTRONICS

WINSLOW

MANUFACTURING CO.

1751 EAST 23 STREET • CLEVELAND 14, OHIO



R/M ASBESTOS-PHENOLICS

hottest weight-savers for hot missile parts

Pound for pound, R/M asbestos-phenolic missile parts give you far greater strength and stability at extreme temperatures than metals.

This amazing family of asbestos reinforced plastics retain their good mechanical properties for the time-temperature relationship required for missile parts. At elevated temperatures where other materials fail, R/M asbestos-phenolics provide superior strength retention and controlled ablation.

R/M asbestos-phenolics are noted for their low thermal conductivity and diffusivity. Because they are based on extra-long spinning grade asbestos fibers, they also assure high strength-to-weight ratios, superior shock resistance, and uniform ablation.

Felts, mats and molding compounds are available from R/M for prompt shipment in production quantities. They are backed by comprehensive technical data and know-how. Write for information and engineering help.

Nozzle of R/M Style 150RPD Pyrotex® molding compound.

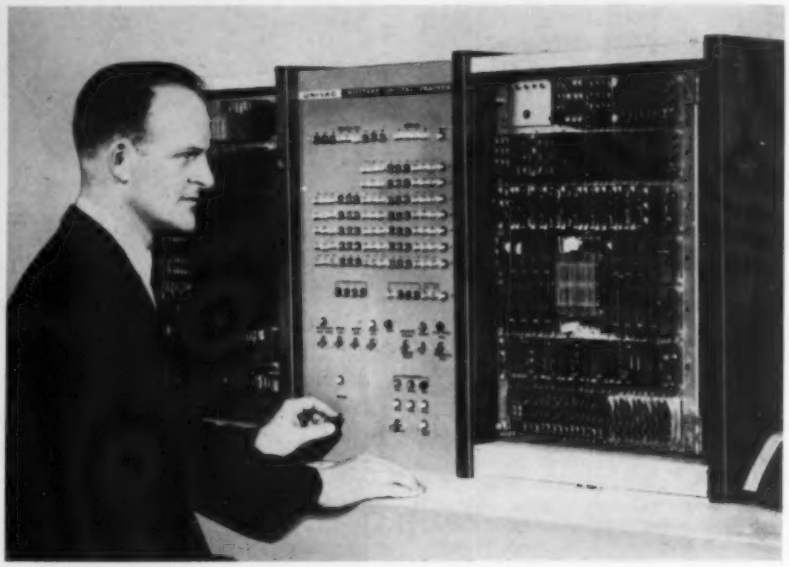
RM

RAYBESTOS-MANHATTAN, INC.

Reinforced Plastics Department, Manheim, Pa.

SPECIALISTS IN ASBESTOS, RUBBER, ENGINEERED PLASTICS, SINTERED METAL

products and processes



New Product of the Week:

Univac's Military Digital Trainer

THE UNIVAC Military Digital Trainer, a desk-size binary computer with many large-scale computer characteristics, is available from the Univac Military Department for applications ranging from training in computer maintenance, design and programing to the solution of many data-processing problems.

The portable unit occupies eight cubic feet of space and operates from 60-cycle, 110v ac power, dissipating a maximum of only 750 watts of electrical power.

Total computer characteristics of the Univac Military Digital Trainer include:

—A high-speed magnetic core memory with 512 fifteen-bit words of random access storage with a read-restore cycle period of 8 microseconds, add time of 24 microseconds, and multiply-divide time of 130 microseconds.

—Single-address instruction repertoire with j-bit options and B box indexing, plus regular divide and multiply instructions.

—A complete console, with all arithmetic and control registers available on the panel for operator intervention and for teaching operator procedures. All logical circuitry and test points are accessible to the operator.

Circle No. 225 on Subscriber Service Card

Dual-gun Storage Tube

A dual-gun, 10-in. storage tube (Storatron) specifically adaptable to missile and satellite tracing is announced by the Electronic Tube Div., Allen B. Dumont Laboratories.

Designated type K-2087, the tube features excellent tracking accuracy between guns and raster orthogonality without resort to on-axis writing. It utilizes a patented gun structure to achieve deflection linearity within 0.1% (no deflection plate current).

Advantages of its dual guns are the ability to track from two separate antennas or two angles or points. Storage time of the tube is from 3 to 10 minutes. The tube is adaptable to TV frequencies and can freeze TV presentations with excellent light output. Any action can be frozen and observed while the action is still taking place.

Circle No. 226 on Subscriber Service Card

Dacron-Epoxy Tubing

A heat-shrinkable dacron-epoxy tubing is being marketed by Westinghouse for slip ring applications. The tubing is intended to provide simple and precise slip ring positioning and to eliminate the

close-tolerance machining operations that are generally necessary for the press-fitted slip rings. It is also intended to eliminate the alternative practice of fitting slip rings by splitting and then bonding the segments to provide increased strength for slip ring structure. Tensile strength is 8500 psi, compressive strength is 17,200 psi, water absorption is 0.18%, and dielectric strength is 407 v per mil.

Circle No. 227 on Subscriber Service Card

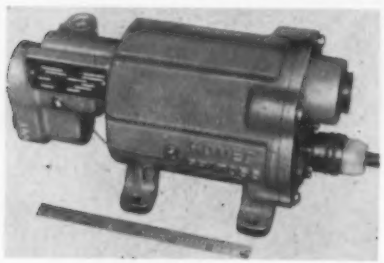
Porcupine Delay Line

Valor Instruments, Inc. has available a miniature, multi-output porcupine delay line with 80 equally spaced taps arranged for easy identification and a very wide variety of delay periods. Model DL 356 has a total delay of 4.0 usec and a tapped output every 0.05 usec. The hermetically sealed, multiple-output, lumped-constant delay line provides flexibility in delay selection for applications such as the proper phasing of multiple-channel tape recorders. Specifications as follows: delay-4.0 usec, rise time-0.15 usec, 80 taps in 0.05 usec intervals, impedance-100 ohms, attenuation-4 db max.

Circle No. 228 on Subscriber Service Card

Coolant Pump

Lear-Romec is manufacturing an electric motor-driven coolant pump for operation in ethylene glycol/water mixtures and other coolant fluids. The motor stator of the RG17050 vane type pump assembly is encapsulated to permit flooded operation in fluids. This design eliminates shaft seals between pump and motor. The pump has a flow range up to 5 gpm and a discharge



pressure setting up to 200 psi. The minimum operating life is 5000 hours. The unit has a displacement of 0.324 cu. in. per revolution and has a non-adjustable relief valve set to bypass full pump flow at 150 psig discharge pressure.

Circle No. 229 on Subscriber Service Card

Photoceram Grid Boards

Additional configurations in Fotoceram printed circuit grid boards have been developed by Corning Electronic Components. The grid boards consist of copper-clad Fotoceram glass-ceramic with a grid of 0.052-in. through-plated holes set 0.1-in. on center. The circuit pattern is laid on the grid with etching resist, then the copper lying beyond the pattern is etched away. After this 15-min. process, the board is ready for components.

Circle No. 230 on Subscriber Service Card

Predetection Receiver

Dymatronics predetection receiver provides, within a single assembly, a means for collecting telemetry data for recording prior to demodulation. I-f output for recording may be selected at 900, 450 or 225 kc. Playback from a magnetic tape recorder may be fed through the receiver and demodulated. Selection of 7 i-f bandwidths is obtained by means of plug-in bandpass filters. Afc is provided, activated by a panel switch, to reduce frequency drifts in the higher telemetry bands.

Circle No. 231 on Subscriber Service Card

new literature

PCM TELEMETRY — A proven "off-the-shelf" PCM telemetry system is described in an illustrated brochure available from Radiation Inc. The brochure describes PCM evolution and the many applications of Radiation's PCM technology, citing systems employed by GE, Thikol and Norair. It also presents a review of the PCM systems designed and built for the Holloman sled program, *Titan* inertial guidance R&D, and *Minuteman* ICBM.

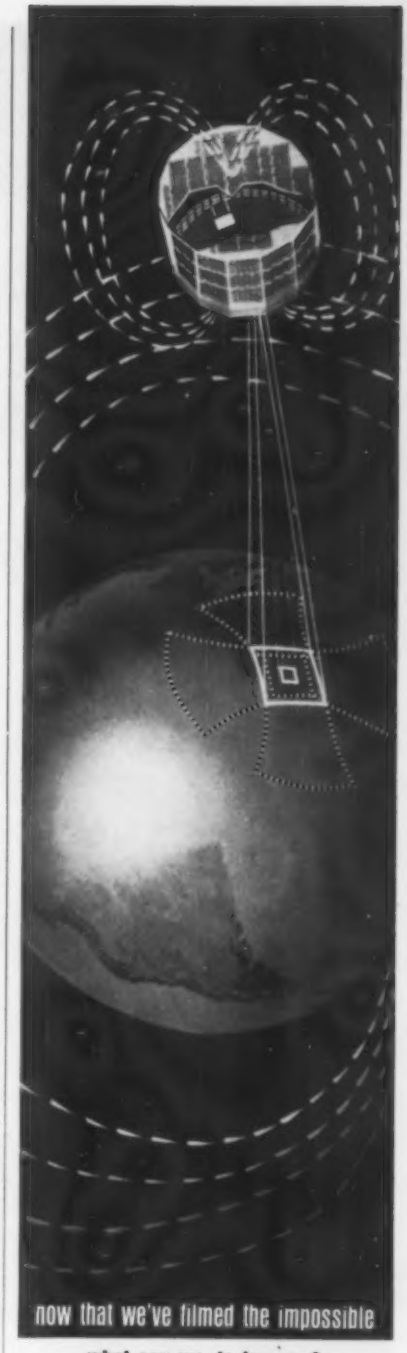
Circle No. 200 on Subscriber Service Card

DATA ACQUISITION — A brochure describing the MicroSADIC digital data acquisition system is available from Consolidated Systems Corp. It provides a technical introduction to MicroSADIC—an integrated, high-speed, general-purpose solid-state system capable of sampling several hundred channels of analog data at up to 15,000 samples per second. The system converts analog information to equivalent digital form and records it on magnetic tape in either binary or binary-coded-decimal mode.

Circle No. 201 on Subscriber Service Card

POWER PACK — Electronic Research Associates, Inc. has published a catalog sheet covering its expanded line of Hypac Miniaturized High-Voltage Solid-State Power Packs. This catalog sheet provides full descriptive and specification data on miniature types with voltage outputs starting at 1000 VDC and extending to 20,000 VDC. Regulated as well as non-regulated units, operating from either a-c or d-c inputs, are described.

Circle No. 202 on Subscriber Service Card



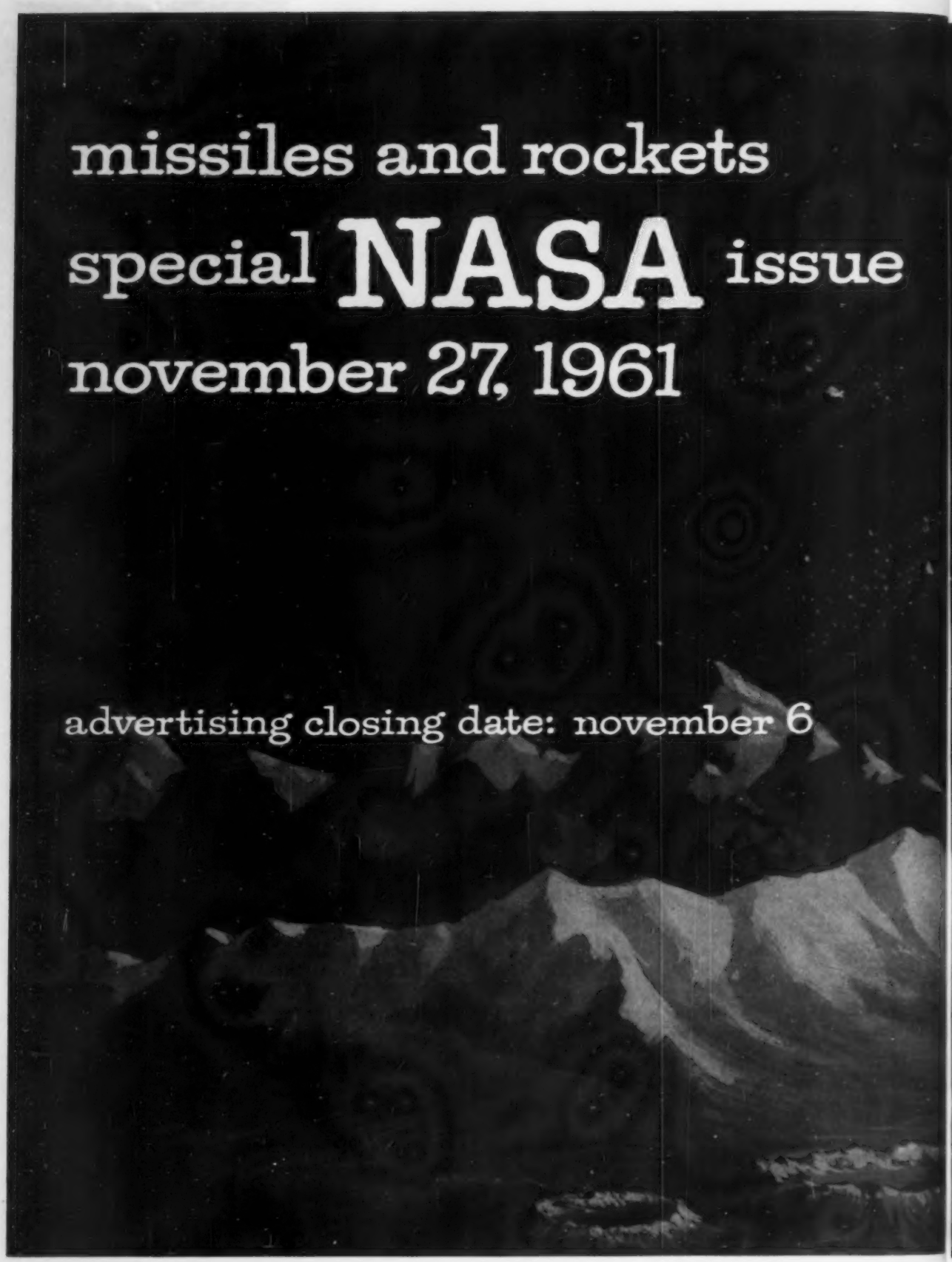
what can we do for you?

We had the answer for TIROS...for NIMBUS. We've had the answer to movie camera, still camera, X-ray camera and aerial camera problems. We've had the answer to problems of high volume-low unit costs; we've had the answer to problems where few-of-a-kind are involved. If your company is facing an optical design problem, Elgeet's engineering and design section welcomes the challenge to create the breakthrough that you require.

Write: Elgeet Optical Company, 838 Smith St., Rochester, N.Y.

Elgeet EL-63

Circle No. 16 on Subscriber Service Card


missiles and rockets
special NASA issue
november 27, 1961
advertising closing date: november 6

contracts

NASA

$3,996,129—Delectronic and Missile Facilities, Inc., New York City, for construction of central lab and office building, Marshall SFC, Huntsville, Ala.

$2,980,000—General Co., Computer Dept., Phoenix, Ariz., for services for computing mission at Marshall SFC.

$300,000—Siegler Corp., New York City, from Goddard SFC, for design and construction of complete video system (spaceborne and ground) for operation 250 miles above the earth.

$217,000—Mt. Vernon Research, Alexandria, Va., for services and materials for space environmental chamber at Langley Research Center.

$66,370—Ferguson Corp., Newport News, Va., for services and materials for building addition and installation of components for the 2000 KW arc jet.

Cook Electric Co.'s Technological Center Div., Morton Grove, Ill., from NASA and University of Wisconsin, for design, development and fabrication of University's experiment package of the *Orbiting Astronomical Observatory*. No amount disclosed.

MISCELLANEOUS

General Vacuum Corp., Medford, Mass., from **Radio Div., Bendix Corp.**, for design and manufacture of ultrahigh-vacuum facility to simulate altitudes equivalent to a pressure of $1x10^{-6}$ torr or higher. No amount disclosed.

NAVY

$11,160,093—Johns Hopkins University, Silver Spring, Md., for continued research on *Bumblebee* missile, *Transit* navigation satellite and other research projects.

$7,600,000—Range Systems Div., Chance Vought Corp., subsidiary of **Ling-Temco-Vought**, for two years' operation and maintenance work for Pacific Missile Range.

$6,300,000—Motorola, Inc., Chicago, for sonobuoys.

$5,000,000—Hughes Aircraft Corp., Culver City, Calif., for production of guidance systems for the *Polaris* missile.

$5,000,000—Raytheon Co., Waltham, Mass., for research and development of *Polaris* missile system.

HI-TEMPERATURE METALS

Tungsten
Molybdenum
Tantalum
and
Others

NOW—
for the first time

Large jacketed nozzle fabricated and welded from pure tungsten sheet.

FABRICATED-WELDED-MACHINED

Super-Temp Corporation now can offer complete fabrication of light or heavy sheet of pure tungsten, molybdenum, tantalum-tungsten and other high temperature metals into almost any shape desired for missiles, space and re-entry vehicles.
Super-Temp's ability to successfully weld segmented parts and assemblies of pure tungsten and other high temperature refractory metals opens up a wide new area for the design and use of these metals. Complete facilities are available for the custom machining, bonding and flame spraying of the heat sinks and insulations necessary for high temperature package assemblies.

SERVICES
Fabrication — Machining
Die Forming — Spinning
Flame Spraying — Bonding
Engineering — Assemblies

PART APPLICATIONS
Nozzles, Liners, Throat Inserts, Rings, Flanges, Shields, Blast Tubes, Elbows, Venturi, Shapes, Cones, Flame Barriers, Structure Applications and Others.

Super-Temp Corporation

2024 W. 15th St., Long Beach 13, Calif.
Phones—HEmlock 6-9236 . . SPruce 5-1600

$4,500,000—Lockheed Missile and Space Co., Sunnyvale, Calif., for production of *Polaris* missile repair parts.

$4,030,782—Thiokol Chemical Corp., Bristol, Pa., from BuWeps, for production of packaged liquid-propellant rocket engines for *Bullpup* missiles.

$3,200,000—Raytheon Co., Lexington, Mass., for design, development and construction of two air-search radar sets.

$1,994,249—Westinghouse Electric Corp., Sunnyvale, Calif., for research and development on *Polaris* missile-launching system.

$1,496,600—General Electric Co., Pittsfield, Mass., for spare parts for *Polaris* missiles.

$1,401,349—Lockheed Electronic Co., Lockheed Aircraft Corp., Plainfield, N.J., for planning and installing hydrophones at sea.

$1,284,250—North American Aviation, Inc., Canoga Park, Calif., for JATO rocket motors.

$1,135,000—Control Data Corp., Minneapolis, for a Model 1604 computer and a 1607 magnetic tape unit.

$1,132,370—Elgin National Watch Co., Los Angeles, for fuzes for *Bullpup* missiles.

$1,000,000—Farmers Tool & Supply Corp., Denver, for wing assemblies for *Sidewinder* missiles.

$800,000—Belock Instrument Corp., College Point, N.Y., from **General Dynamics/Pomona**, for manufacture of precision instrumentation for use in *Tartar* and *Terrier* missile programs.

$230,000—Cedar Engineering Div., Control Data Corp., Minneapolis, from **Raytheon Co.**, for *Sparrow III* missile components.

Baird-Atomic, Inc., Cambridge, Mass., from **Applied Physics Laboratory, Johns Hopkins University**, for scientific study in connection with *Transit* navigational satellite program. No amount disclosed.

Telecomputing Corp., Los Angeles, from **Lockheed Missiles and Space Co.**, for development and manufacture of automatically-activated primary battery to furnish in-flight electrical power for *Polaris* A3 guidance system. No amount disclosed.

Guidance Technology, Inc., Santa Monica, Calif. from **Martin/Orlando**, for spring-driven gyros for use in *Bullpup* missile. No amount disclosed.

ARMY

$65,802,655—Avco Corp.'s Electronic & Ordnance Div., Evendale, Ohio, for AN/VRC-12 series of radio receiver-transmitters.

$8,000,000—Ford Motor Co., Aeronutronic Div., Newport Beach, Calif., for continued development of *Shillelagh* missile system.

$314,700—Sylvania's Electronic Defense Laboratories, Mountain View, Calif., for design and prototype production of electronic warfare equipment.

AIR FORCE

$6,900,000—Douglas Aircraft Co., Santa Monica, Calif., for development of a capability for air-to-air rocket fuze production.

$3,700,000—Lockheed-Georgia Co., Marietta, for machine tool modernization.

$2,517,000—Massachusetts Institute of Technology, for continuation of work at Cambridge on a high-field magnet laboratory.

$2,500,000—General Dynamics, Ft. Worth, for development of design criteria for nuclear-powered aerospace systems.

$2,300,000—Sylvania Electric Products, Inc., Dayton, Ohio, a subsidiary of **GT&E**, for development and manufacture of magnetrons and klystrons.

$1,933,724—The Compudyne Corp., Hatboro, Pa., for fabricating 57 sets of hydraulic systems for a *Titan II* facility.

$1,900,000—Kollsman Instrument Corp., Elmhurst, N.J., subsidiary of **Standard Kollsman Industries, Inc.**, for automatic astro compasses.

$1,089,000—Columbia University, New York City, for research in mid-course identification and tracking of ballistic objects.

$1,002,830—Bomac Laboratories, Inc., Beverly, Mass., for production of electron tubes for classified projects.

$650,000—General Electric's Defense Systems Dept., Syracuse, N.Y., for initial spare parts for MISTRAM.

$467,200—Allison Div., General Motors Corp., Indianapolis, from **Aerojet-General Corp.**, for titanium second-stage rocket engine cases for *Minuteman ICBM*.

Solar Aircraft Co., San Diego, from Aeronautical Systems Div., for development, fabrication and testing of aerospace vehicle frontal sections. **Lockheed Missiles and Space Co.** will perform trajectory and structural analysis. No amount disclosed.

Sperry Gyroscope Co., Great Neck, N.Y., for a study to determine what new electronic countermeasures techniques may further ensure that U.S. missiles can penetrate enemy radar defense. No amount disclosed.

M/R BUSINESS OFFICES

Washington 5, D.C.—1001 Vermont Avenue, NW; STerling 3-5400
Edward D. Muhlfeld, Publisher

New York 17, N.Y.—20 East 46 Street; YUkon 6-3900
Paul B. Kinney, Eastern Advertising Manager
Paul N. Anderson

Beverly Hills, California—8929 Wilshire Blvd.; OLeander 5-9161
Ronald L. Rose
Edwin J. Denker, Jr.

San Francisco, California—859 The Dalles, Sunnyvale: RE 6-4017
James W. Clear

Detroit 2, Michigan—412 Fisher Building; TRinity 5-2555
Michael Rouff

Chicago 2, Illinois—139 N. Clark St.; Central 6-5804
R. Lenn Franke, Jr.

Dallas 24, Texas—222 Wynnewood Professional Building
John L. Hathaway

Miami, Florida—208 Almeria Ave., Coral Gables
Richard D. Hager

London, W.1., England—28 Bruton Street; Grosvenor 8356
Norall and Hart

Geneva, Switzerland—10 Rue Grenus; Geneva 321044

Paris, France—11 Rue Condorcet; TRU 15-39

Frankfurt/Main, West Germany—Friedrich-Ebert-Anlage 3

when and where

OCTOBER

National Conference on Industrial Hydraulics, Versatility and Reliability of Fluid Power, Sherman Hotel, Chicago, Oct. 19-20.

East Coast Conference on Aerospace and Navigational Electronics (ECCANE), Lord Baltimore Hotel, Baltimore, Oct. 23-25.

IRE Aero-Space Nuclear Propulsion International Symposium, Las Vegas, Nev., Oct. 23-27.

Bi-annual U. S. Air Force Interceptor Weapons Meet (William Tell 1961), Tyndall AFB, Fla. Oct. 23-Nov. 3.

Joint Meeting, Canadian Aeronautical Institute/Institute of the Aerospace Sciences, Ottawa, Oct. 23-24.

URSI-IRE Fall Meeting, University of Texas, Austin, Oct. 23-25.

Fifth Annual Varian Nuclear Magnetic Resonance-Electron Paramagnetic Resonance Workshop, Stanford University, Palo Alto, Calif., Oct. 23-27.

43rd National Metal Congress, sponsored by American Society for Metals and eight participating organizations, and 1961 Detroit Metal Show and ASM Materials Comparison Center, Cobo Hall, Detroit, Oct. 23-27.

Bi-Annual U.S. Air Force Interceptor Weapons Meet (William Tell 1961), Tyndall AFB, Fla., Oct. 23-Nov. 3.

National Association of Corrosion Engineers, South Central Regional Meeting, Shamrock Hilton Hotel, Houston, Oct. 24-27.

International Symposium on Aerospace Nuclear Propulsion, AEC, NASA, IRE, Riviera Hotel, Las Vegas, Nev., Oct. 24-26.

1961 Computer Applications Symposium, sponsored by Armour Research Foundation, Morrison Hotel, Chicago, Oct. 25-26.

National Management Association, 1961 Annual Conference, Sherman Hotel, Chicago, Oct. 25-27.

Instrumentation Facilities for Biomedical Research Symposium, Sheraton Fontenelle Hotel, Omaha, Oct. 26-27.

1961 Electron Devices Meeting, IRE, Sheraton Park Hotel, Washington, D.C., Oct. 26-28.

1961 Aero/Space Fluid Power Conference, Seminar sponsored by Aero Hydraulics Division of Vickers, Inc., Pick-Fort Shelby Hotel, Detroit, Oct. 30-31.

Advertisers' Index

Aeroquip Corporation 3
Agency—The Fred M. Randall Co.
American Bosch Arma Corp., Arma Div. 18
Agency—Doyle, Kitchen & McCormick, Inc.
Bell Aerosystems Co., Div. of Bell Aerospace Corp. 2
Agency—Comstock & Co., Adv.
Bendix Corp., The Scintilla Div. 7
Agency—MacManus, John & Adams, Inc.
Boeing Co. 6
Agency—Fletcher, Richards, Calkins & Holden, Inc.
Cohu Electronics, Inc., Kin Tel Div. 10
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.
Consolidated Electrodynamics Corp. ..... 46 & 47
Agency—Hixson & Jorgensen, Inc.
Defense Systems Div., General Motors Corp. 59
Agency—D. P. Brother & Co.
Douglas Aircraft Co., Inc. 35
Agency—J. Walter Thompson Co.
Dunn Engineering Corp. 8
Agency—S. Gunnar Myrbeck & Co.
Elgeet Optical Co., Inc. 53
Agency—The Wexton Co.
Ford Instrument Co., Div. of Sperry Rand Corp. 13
Agency—Chirurg & Cairns, Inc.
General American Transportation Corp. 24
Agency—Edward H. Weiss & Co.
General Dynamics/ Astronautics 37, 38, 39, 40
Agency—Barnes Chase, Adv.
General Electric Co. Defense Systems Dept. 34
Agency—Deutsch & Shea, Inc.
Hughes Aircraft Co. 30
Agency—Foote, Cone & Belding
Mitre Corp., The 4
Agency—The Bresnick Co., Inc.
Pan American World Airways, Inc., Guided Missiles Range Div. 60
Agency—Willard E. Botts, Adv., Inc.
Poly-Scientific Corp. 50
Agency—Houck & Company, Inc.
Radio Corp. of America, Defense Electronics Products 23
Agency—Al Paul Lefton Co.
Reinforced Plastics, Dept. of Raybestos Manhattan, Inc. 52
Agency—Gray & Rogers, Adv.
Rocket Power Inc. 43
Agency—Getz & Sandborg, Inc.
Sperry Marine Div. 36
Agency—Reach, McClinton & Co., Inc.
Super-Temp Corp. 56
Thiokol Chemical Corp., Rocket Div. ..... 28 & 29
Agency—Hicks & Greist, Inc.
United Technology Corp., Sub. United Aircraft Corp. 45
Agency—Campbell-Ewald Co.
Winslow Mfg. Co. 51
Agency—Gates-Bourgeois Adv. Agency
Zero Mfg. Co. 12
Agency—Guerin, Johnstone, Gage, Inc.

Classified

LOOKING FOR WAVEGUIDES?
Turn to section 3400

eem — ELECTRONIC ENGINEERS MASTER

LOOKING FOR CONTROLS?
Turn to section 2200

eem — ELECTRONIC ENGINEERS MASTER

LOOKING FOR TRANSISTORS?
Turn to section 4800

eem — ELECTRONIC ENGINEERS MASTER

Employment

SOLID PROPELLANT ENGINEER FOR EUROPE

Leading rocket company has opening for a design engineer in the field of solid propellant motor development. This position requires motor design and tooling for pilot plant production. Knowledge of modern materials, design and fabrication methods for pressure vessel enclosures, nozzles and chamber linings required. Experience in testing and inspection of small rocket motors.

Applicants should be willing to stay in Europe at least 3 years. Round-trip paid. New York Interview.

Apply Box 70,
MISSILES AND ROCKETS Magazine.
1001 Vermont Ave., N.W.
Washington 5, D.C.

editorial . . .

Enough of This Non-Profiteering

VICE PRESIDENT JOHNSON has just concluded a morale-boosting jet tour of missile/space installations in the West. These included NASA's Ames Research Center near San Francisco, Edwards AFB, Jet Propulsion Laboratory, Vandenberg AFB, the Pt. Arguello facility of the Pacific Missile Range, and the Aerospace Medical Center in Texas.

This indication of top-level interest in the working base of the nation's space program is heartening, not only to those employed at the bases visited, but to everyone connected with the program.

We are pleased to hear that such visits will continue. As head of the Space Council, the Vice President is, of course, directly concerned with the space program and the problems it encounters. His decision to gather his information first-hand most certainly is to be commended.

But the most immediate benefit of the tour was its quite discernible effect on morale.

"We have lots of visits from program directors," a JPL scientist told our West Coast bureau chief, Dick van Osten, "but this is the first time anyone from this echelon of the government has visited us. We need and appreciate it."

The enthusiasm over the Vice President's visit was evident in the NASA briefings, which at times slipped into hearty and undisguised salesmanship.

"We're proud of what we're doing," an Ames Research Center engineer said. "If we're selling too hard, it's because we believe in what we're doing and want the people who pay for it to know about it."

Vice President Johnson surprised several of his briefers with the questions he asked.

"He has a fine grasp of what's going on in our areas," a JPL engineer said, "considering all the other things he has to worry about."

Johnson, in his talks with NASA personnel, stressed the importance of the nation's efforts in space and President Kennedy's own intense personal interest in the space program. The Vice President's words and his own sincere interest produced a strongly favorable reaction at all echelons.

As bureau chief van Osten reports, "Enthusiasm is one thing and progress something else in space programs, but Johnson's trip undoubtedly will pay off."

While we are pleased with the enthusiasm generated by the Vice President's trip, we are less than happy with some of the news emanating from the tour. We are referring to newspaper reports that NASA is planning to set up yet another non-profit corporation, this one to help run the space program.

Civil service salary scales certainly are a problem, as the Vice President learned on his tour. He was deeply impressed by the difficulties NASA has in holding top-notch scientists and engineers against the lure of higher-paying jobs in industry.

But we are disappointed at the suggestion that another non-profit firm is a necessity. Such an organization could take one of two forms—neither of which offers strong appeal. It could be set up along the lines of Aerospace Corp. as a scientific-technical organization to provide program management and/or technical evaluation. If this is contemplated, one question immediately arises. Why not use Aerospace Corp.? Aerospace was, of course, established primarily for the benefit of the Air Force and its first acceptance of a small NASA contract met with strong Air Force opposition.

The Air Force should be told to go suck its thumb elsewhere. If Aerospace can be useful to NASA, it should be so employed.

The other non-profit approach would be to set up a group similar to the Institute for Defense Analysis employed by the Department of Defense to get some high-priced talent for the Pentagon. Under this concept, the non-civil service talent would be spread throughout NASA; the corporation itself would be merely a dummy organization.

The problems such an "elite corps" would create can easily be imagined.

WE WOULD LIKE to make a few suggestions. Non-profit corporations are proliferating at a great rate. Deputy Defense Secretary Roswell Gilpatric announced in New York the other day that the Pentagon is about to create another one—to study ways of improving military procurement. If civil service salary scales really are so bad that no worthwhile talent will remain with the government, perhaps a new look at government pay scales is in order. Otherwise, we shall be up to our navels in non-profit corporations in a very short time.

Second is the fact that, properly motivated, many people of very considerable talent have in the past and will in the future work for the government despite the offer of higher-paying outside jobs. Indications of appreciation and interest such as the Vice President's just-concluded tour do much to provide that motivation.

But the third and most obvious answer to the problem is this: If industry, due to its higher wage-scale, has the talent needed, then let industry do the job.

Administrator James Webb has said NASA will rely heavily on industry in the space program. We hope he holds firmly to that philosophy.

Another non-profit firm we can do without.

William J. Coughlin

GM's DSD speeds the answer!

In the Flight Physics Laboratory of General Motors Defense Systems Division, projectiles are boosted to fantastic speeds. Velocities of 31,000 feet per second have already been achieved. Flights at 40,000 feet per second or faster are felt to be attainable in the near future. Studies are under way of missile signatures, high-speed impact, properties of ionized gases. New or refined methods of detection, identification, communication and navigation are now under development, and are now being studied in this unique facility. And the results of these studies may well be of great significance in pointing the way to new methods of defense. Unusual studies like these, unusual facilities, and unusually capable men present a great challenge and opportunity to scientists and engineers who are qualified to make a solid contribution at any level. DSD is now, as always, searching for new talent in these areas.

Scientific areas now under study: ■ Aero-Space ■ Sea Operations ■ Land Operations ■ Biological Systems ■ Technical Specialties

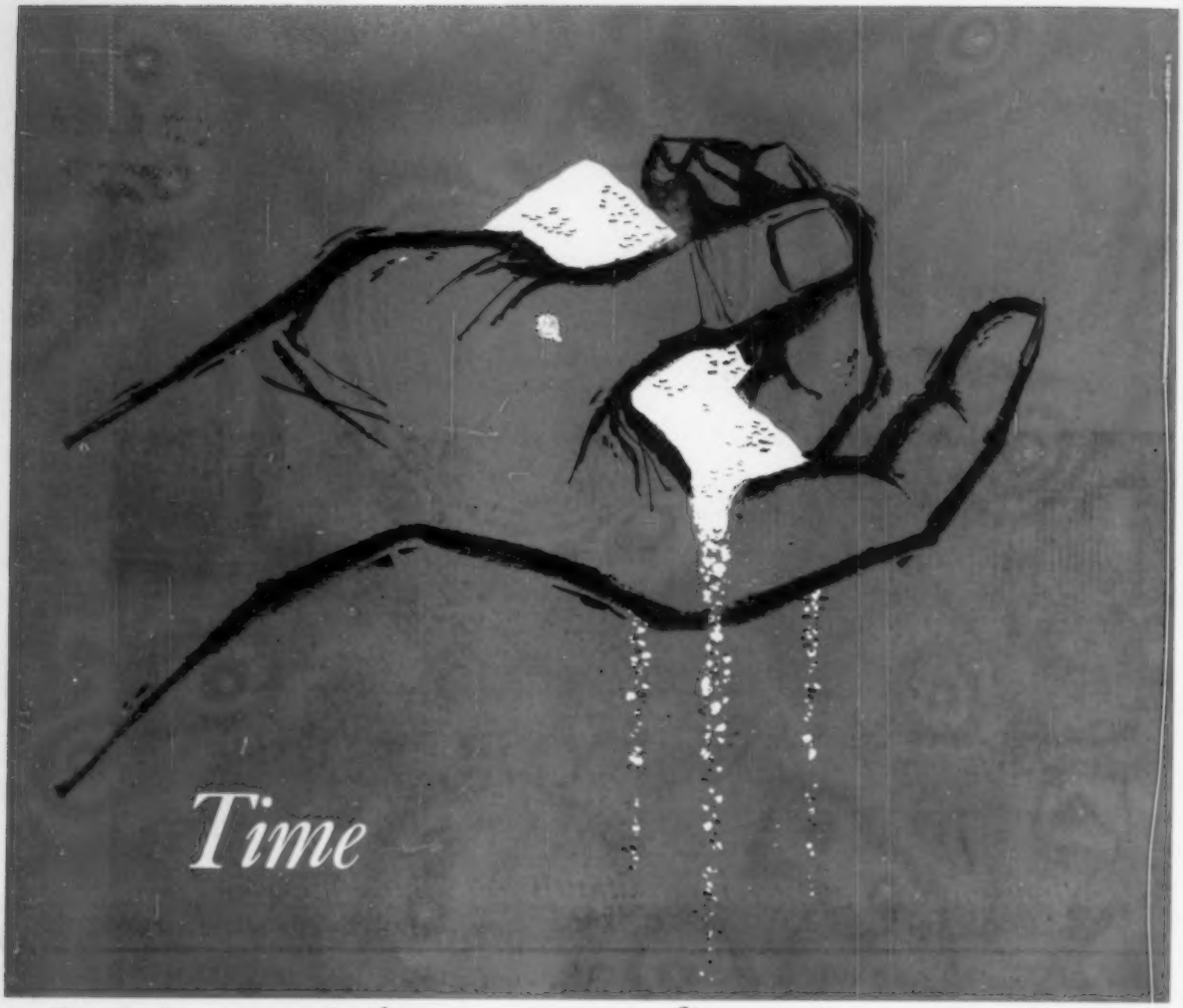
High-Velocity Impact—This is an actual photograph of the crater blasted into a block of solid aluminum by a nylon projectile in tests conducted in DSD's unique Flight Physics Laboratory. Here projectiles from two light gas guns are studied at close range, while flying faster than man has ever been able to fly them before . . . up to 31,000 feet per second. If you can use facilities like these, contact DSD.

GENERAL MOTORS

DEFENSE SYSTEMS DIVISION

DEFENSE SYSTEMS DIVISION OF GENERAL MOTORS CORPORATION • WARREN, MICHIGAN AND SANTA BARBARA, CALIFORNIA

Circle No. 12 on Subscriber Service Card



Time is a sandpile we run our fingers in . . . Sandburg

Guided Missiles Range Division of Pan American World Airways, Inc. is continuing to increase the technical staffs in Planning, Engineering and Operations Departments as a part of a well-organized systematic expansion program.

The programs are important . . . the funds are available . . . the tools are at hand. The need is for technically respected people with leadership ability to carry out these programs.

New career positions are now available for physicists, engineers and mathematicians with B.S., M.S., and Ph.D. degrees. These opportunities will be filled by professionally qualified men whose capabilities, experience and will to win are unbounded.

Now evaluate your position and determine for yourself whether a career with GMRD is for you.

Address your resume in confidence to: Professional Employment Manager, Guided Missiles Range Division, PAN AMERICAN WORLD AIRWAYS, INC., Dept. V-43, P. O. Box 4336, MU 113, Patrick Air Force Base, Florida. Inquiries will receive prompt replies and all qualified applicants will be considered for employment without regard to race, creed, color or national origin.

PAN AM

GUIDED MISSILES RANGE DIVISION

PATRICK AIR FORCE BASE, FLORIDA

Circle No. 13 on Subscriber Service Card